



The Journal of  
Laryngology and Otology



# The Journal of Laryngology and Otology

EDITED BY  
WALTER HOWARTH

WITH THE ASSISTANCE OF  
W. M. MOLLISON

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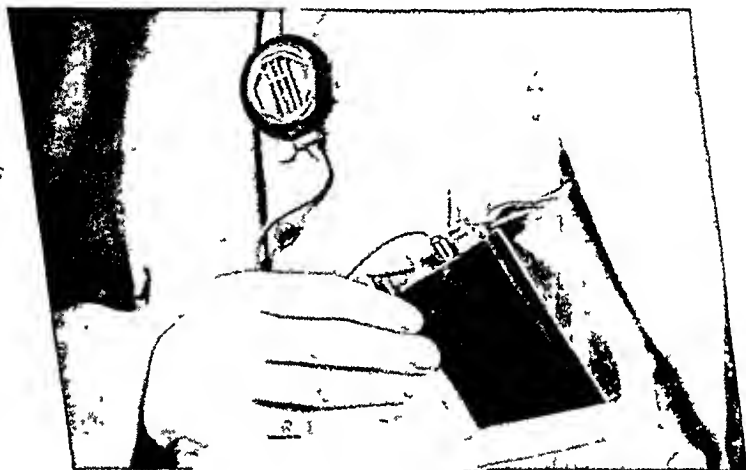
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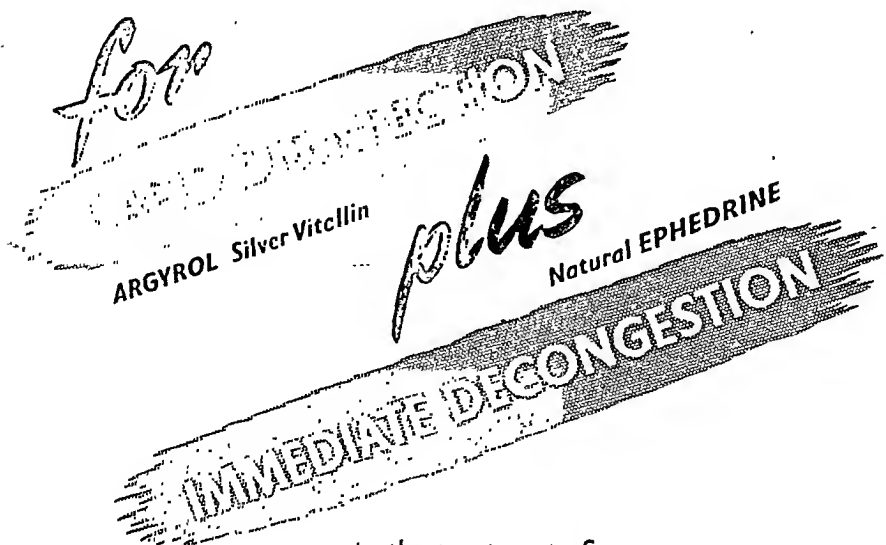
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*January 1944*

## INJURY TO THE EARS AMONG BATTLE CASUALTIES OF THE WESTERN DESERT

By MAJOR E. G. COLLINS, R.A.M.C.

EVIDENCE is gradually accumulating that the increasing blast pressures from the explosives now in use affect the ears in a far higher percentage than formerly and the subject of blast injuries to the ears becomes of real importance to the Army and especially to Army otologists.

At the end of the first battle of Libya I was impressed by the frequency with which I was called into consultation to the surgical wards of a Base Hospital to give an opinion about some battle casualty who was complaining of deafness or discharging ears. When the casualties from the second battle of Libya started to arrive in November, 1941, I thought it might be of some value to examine the ears of as many battle casualties as possible, irrespective of whether they had any aural complaint. In February, 1942, I was transferred to Tobruk and there fresh opportunity arose to examine the battle casualties in a very early stage. This clinical investigation, consequently, covers a period of seven months from November, 1941, up to the fall of Tobruk on June 20th, 1942. The total number of battle casualties examined was 885. Unfortunately, when the largest number of wounded arrived at Tobruk Hospital in the third battle of Libya, the opportunities for leisure and the conduct of a clinical investigation were fleeting, as every available officer with surgical experience was required in the operating theatre and the otologist became a general surgeon.

The conditions of examination were never ideal and no pretence is made that this was a thoroughly scientific investigation. Background noise for the testing of hearing was very variable and frequently the tests



Medicine in 1940. It will be found that some of the opinions expressed in this article differ materially from the accepted views, especially as regards the incidence of rupture of the tympanic membrane in association with concussion or inner-ear deafness. The statement is sometimes made that rupture of the tympanic membrane protects the inner ear against concussion and that the soldier who sustains a rupture of his drum head is likely to be left with little residual deafness. This generalization I believe to be exaggerated and I do not consider that the rupture of the tympanic membrane plays any part in determining either the absence or the severity of the damage to the cochlea.

It is my opinion that the inner-ear damage occurs before any rupture of the tympanic membrane can take place and that the severity of cochlear damage is directly related to the intensity of the blast pressure.

Regarding the possibility that the intrinsic muscles of the middle ear can exert any considerable function in protecting the middle or internal ear against blast this seems unlikely. Hallpike and Rawdon-Smith demonstrated in 1934 by oscillographic methods that the reflex contractions of these muscles in response to a train of sound waves bring about a decrease in amplitude of the electrical response of the cochlea. The amplitude reduction was not, however, very large (6 db.), and an important time relation was also established, namely, that the full extent of this "damping action" is not developed until some 30 milliseconds after the onset of the stimulus. Much too late, therefore, to afford any protection against the almost instantaneous shock wave of blast.

I consider that whether the tympanic membrane ruptures or not depends mainly on the relation of the blast pressure wave to the axis of the external auditory meatus and that the rupture of the tympanic membrane is relatively unimportant were it not for the fact that infection of the middle ear is liable to supervene. A minor factor in the causation of a rupture of the drum head may be some variation in its density but this is probably not of great significance. The important point is that a tympanic membrane can rupture from quite a low blast pressure and consequently the inner ear often escapes serious damage. As, however, in addition to slight deafness and tinnitus, there may be bleeding and pain the patient frequently seeks specialist advice, whereas an equal degree of deafness and tinnitus accompanied by an intact tympanic membrane is accepted as a normal accompaniment of an explosion and it is only when the deafness is more marked or residual that the latter group visit the otologist. This disparity in the incidence of examination between the two groups is itself misleading and has led to the generalization that a soldier who sustains a rupture of the drum head will have little or no residual deafness. Frequently, however, the strength of the blast pressure which ruptures the drum head will be high and the inner ear will be damaged. In the present investigation I found that about 40 per cent.

# Injury to the Ears Among Battle Casualties

of the patients who sustained a rupture of the tympanic membrane had a considerable degree of initial deafness of a "mixed" type. By that, I mean that there was some *initial* damage to the inner ear which was often masked by the middle-ear deafness present. What proportion of soldiers with this *initial* inner-ear damage will have a permanent residual deafness I am unable to state, as attempts to institute a follow-up system were frustrated by enemy action. My own observations suggest that the majority will show good recovery of hearing except for some high tone loss which will not constitute a serious disability but that an undetermined but by no means negligible percentage of patients who sustain rupture of the tympanic membrane will be left with permanent residual deafness of a severe degree. Some support for this contention is given by a recent investigation which I made of 83 soldiers who had sustained aural trauma from gunfire. It was estimated that about half the patients had sustained a rupture of the tympanic membrane as far as could be ascertained from the history, appearance on examination and reports from medical officers or other otologists. In about 30 per cent of patients the audiometer showed a severe residual deafness which was usually of an inner-ear type and the percentage was just as great among the men who sustained a rupture of the tympanic membrane as among the remainder in whom it was considered the tympanic membrane had been intact. Unfortunately in the present investigation the facilities for examination were not so good and for the diagnosis of an initial "mixed" type of deafness I relied mainly on a diminution of the bone conduction which exceeded five seconds and a loss of high tones. As the middle ear was quite often infected the Rinne test did not prove of much value but lateralization for the hearing of the tuning fork to the better ear was considered to be confirmatory evidence of inner ear trauma. The hearing for the whisper and conversational voice was also recorded and Table II shows the types of injury present together with the character of the missile responsible.

TABLE II  
RELATIONSHIP OF MISSILE TO INITIAL AURAL TRAUMA

Type of Aural Injury	Land Mine	Bomb	Shell	Hand grenade	Bullet
Injury to Tympanic Membrane with normal hearing or middle ear deafness only	21	27	32	11	2
Injury to Tympanic Membrane with mixed type of deafness	20	19	25	4	1
Intact Tympanic Membrane with inner ear deafness only	3	—	15	—	1
Total	44	46	72	15	4

It will be noticed that in the present series of patients, the shell was still responsible for the greatest number of aural casualties but considerable variations occurred during the seven months depending on whether an actual battle was in progress.

Aural injuries caused by blast will now be discussed under anatomical headings, but it should again be emphasized that one or all of the injuries may occur in the same patient.

### 1. BLAST INJURY TO THE EXTERNAL EAR.

Blast injury to the external ear is of importance because of the scorching and impregnation of the skin with dirt and cordite. This may cause considerable serous discharge which may trickle into the external auditory meatus and infect the middle ear through a rupture of the tympanic membrane. This injury was most frequently seen in blast from a land mine or hand grenade. In some patients the external ear became considerably swollen and inflamed and in two patients a perichondritis of the external ear developed.

### 2. BLAST INJURY TO THE TYMPANIC MEMBRANE.

Blast injury of the tympanic membrane may vary from small petechial hæmorrhages to almost total destruction of the membrane propria. In twenty patients the former condition was observed but only one case of the latter was seen, where a sailor had been blown off a torpedoed ship into the sea and the middle ear had become infected. Negus (1940) has given an accurate description of the punched out appearance of the perforation seen in the majority of the patients, but if the tympanic membrane is examined within a very short time of the injury, the perforation frequently assumes a more slit-like form. About 20 per cent. of the patients were seen within twenty-four hours of injury. In only five patients was any eversion of the edges of the perforation noticed, which might have indicated that it was the suction wave of blast which was responsible for their aural injury. I am of the opinion that the aural trauma usually is caused by the positive phase of blast. Of the 162 patients who had a rupture of the tympanic membrane, the injury was bilateral in 53. A feature which I have not seen described is the occurrence of multiple perforations in the same tympanic membranes. This was noticed in seven patients. Usually these multiple perforations are not more than two in number, but in one patient there was a cluster of four perforations in a rosette form round the umbo. A considerable amount of discussion has centred round the site of the perforation, though the interest in this point is mainly theoretical. In the present investigation,

# Injury to the Ears Among Battle Casualties

out of the 218 perforations observed, the site of the perforation was as follows :

Anterior	..	..	71
Posterior	..	..	86
Inferior	..	..	41
Central	..	..	20

The anterior perforations tended to be more in the antero-inferior quadrant, whilst the posterior perforations were fairly equally divided between the postero-superior and postero-inferior quadrants. Only one perforation of Shrapnell's membrane was seen and there was some doubt whether this was of traumatic origin. If no infection of the middle ear supervenes, the vast majority of the perforations heal well with an almost invisible scar, provided the perforation is not too large. The average time for healing is a month to six weeks, but repeated trauma will delay this, as was seen in the case of a gunner who sustained a moderate-sized rupture of the tympanic membrane but continued in the gun-crew. Although there was no infection of the middle ear, the perforation showed no signs of healing five months later, and, if any large number of rounds were fired, the man experienced slight bleeding from the ear. It is a curious fact that the size of the perforation does not bear any very direct relation to the weight of the missile. Two patients, who had experienced the explosion of a 250 lb. bomb 6 to 10 feet away had smaller perforations than some who had suffered a similar aural injury from land mines. This may be because the land mine gives a low spread of blast and has a high ratio of explosive to its weight of metal.

## 3. BLAST INJURY TO THE MIDDLE EAR.

Five patients showed hæmorrhage into the middle ear. This usually absorbed fairly rapidly and did not cause a great degree of deafness. An undetermined but possible injury in two patients was rupture of the tensor tympani or stapedius muscle. These two patients, who were seen a fortnight to three weeks after their injury, had what appeared to be a resolving hæmorrhage in the middle ear with great sensitivity to any loud noise. No rupture of the tympanic membrane was present. But gross injuries of the middle ear may result and in one patient there was total destruction of the tympanic membrane with loss of the malleus and incus, and in two others there appeared to be a fracture of the handle of the malleus. Infection is by far the most frequent cause of damage to the middle ear as the result of blast. Of the 218 traumatic perforations examined (this includes bilateral perforations) 57 had middle-ear infection. This is equal to 22 per cent. of the ruptured tympanic membranes. There are four possible causes for infection of the middle ear, which I would place in the following order of frequency. Firstly, the introduction of

foreign material and organisms blown into the middle ear by the blast. This I believe to be quite frequent as in at least 75 per cent. of the patients with aural injury, I was the first person to examine their ears and a number of them were already infected.

Secondly, infection may be caused by an otitis externa which the patient has had before his injury. This condition was very prevalent in the Middle East and was noticed in nineteen of the patients with aural injuries. Thirdly, faulty treatment by the Medical Officer may be responsible. With each succeeding battle in the Western Desert, it was apparent that Medical Officers were becoming increasingly aware that the correct form of treatment for a rupture of the tympanic membrane is "masterly inactivity" and the reference of the patient to an otologist. The cases where Medical Officers instilled drops or syringed out the ears became fewer in number, partly owing to increased experience and partly to the effect of propaganda. The fourth possible cause of infections of the middle ear is nasopharyngeal sepsis. The throat and nose were examined in most of the patients, but in very few was any nasopharyngeal sepsis found. Usually the infection of the middle ear was of low virulence and, as far as it is known, in only three patients out of fifty-seven infected middle ears did a mastoiditis develop which demanded operation. If the aural discharge is treated early, the infection will clear up, but if left untreated, even infection of low virulence may progress to a chronic suppurative otitis media which will persist throughout life. In many of these patients, even though the infection subsides, there is a tendency for persistence of the perforation or delayed healing with scarring of the drum head, chalk deposits and middle-ear adhesions. Such a sequela is liable to leave a residual middle-ear deafness apart from any concussion deafness which may be present. The effect of blast on a patient with a pre-existing chronic suppurative otitis media is to cause a flare up of the discharge and bleeding from the ear may occur if granulations are present. Theoretically such patients should be less liable to a concussion deafness but whether this is the case is still undetermined.

#### 4. BLAST INJURY TO THE INNER EAR.

Blast injury to the inner ear may be considered under the two headings of injury to the auditory labyrinth and injury to the vestibular labyrinth.

(a) *Blast Injury to the Auditory Labyrinth*.—The work of John Fraser and J. S. Fraser (1917) would suggest that the probable pathological lesion is damage to that part of the organ of Corti which is situated near the basal coil of the cochlea. On histological examination the organ of Corti assumes a ghost-like appearance with the disappearance of some of the hair cells. Hæmorrhage into the endolymph and also into the internal auditory meatus have also been recorded. Stevens and Davis (1938)

# Injury to the Ears Among Battle Casualties

discussing industrial aural trauma, have pointed out that the basal turn of the cochlea is in close proximity to the oval window and that it is the part most exposed to the initial violence of the thrusts of the stapes caused by loud noises. The basal turn of the cochlea is responsible for the appreciation of high tones. Consequently, although the original impulse may be of low frequency, a high tone loss must often result.

With war injuries to the inner ear, it is probable that the cochlea suffers damage over a far wider area than ever occurs in industrial trauma, and as will be seen in the audiograms of the four cases described below. The "tonal dip" at the frequency 4096, which is such a feature of industrial acoustic trauma, is comparatively seldom present in blast injuries. Reference has already been made to the occurrence of cochlear deafness in association with ruptured tympanic membranes, but the following four examples of residual concussion deafness were investigated with an audiometer under much better conditions than was possible in the Western Desert.

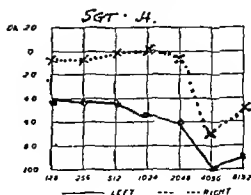
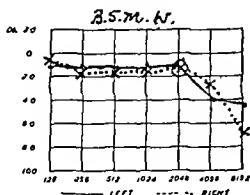
## CASE I.—B.S.M.W.

In April, 1941, whilst the patient was engaged in the Bristol defences, a 250 lb. bomb exploded 8 yards away. The patient sustained no wounds but was blown over by the blast. Marked deafness and tinnitus were noted especially in the right ear. He saw an otologist next day who stated that the right tympanic membrane was perforated and for ten days the right ear discharged. Constant tinnitus is still present in the right ear with some deafness in both ears, though this latter symptom is not so marked as it was at the time of the injury. Before his aural injury his hearing was good and he had never experienced any aural discharge.

## EXAMINATION. 25.8.43.

*Right Ear.*—Healed anterior perforation. Autoinflation +. Conversational voice 30 ft. Whispered voice 21-30 ft. Watch 5-36 in. Rinne + ve. A.B.C. (Absolute Bone Conduction) decreased 9 secs.

*Left Ear.*—L.T.M. (Left Tympanic Membrane) normal. Autoinflation +. Conversational voice 26 ft. Whispered voice 18-30 ft. Watch 7-36 in. Rinne + ve. A.B.C. decreased 6 secs. Weber lateralized slightly to the right.



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## CASE. 2 Sgt. H.

In March, 1943, whilst on range duty, a 3 in. mortar bomb fell about 75 yards away and the patient was knocked down by the blast but sustained no wounds. At first, deafness and tinnitus were marked in both ears. Though the deafness has gradually improved, the tinnitus has remained constant. There was no bleeding from either ear. The previous aural history is negative.

### EXAMINATION. 5.9.43

*Right Ear.*—R.T.M. normal. Autoinflation +. Conversational voice 30 ft. Whispered voice 20-30 ft. Watch 5-36 in. Rinne + ve. A.B.C. practically normal.

*Left Ear.*—L.T.M. normal. Autoinflation +. Conversational voice 30 ft. Whispered voice 13-30 ft. Watch 3-36 in. Rinne + ve. A.B.C. practically normal. Weber lateralized to the right ear.

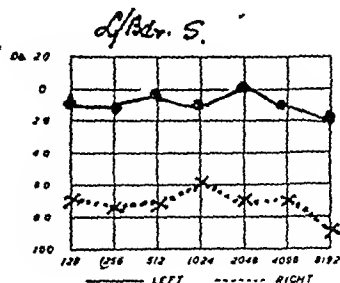
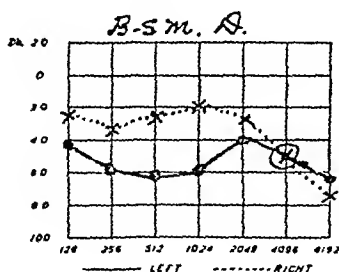
## CASE 3. B.S.M.D.

In February, 1942, a 1,000 lb. bomb dropped approximately 50 yards away from him. The patient experienced severe deafness in both ears but no bleeding from the ears. There has been some improvement in the hearing, but considerable deafness still remains, especially in the left ear. He did not have any tinnitus at the time of the incident but this symptom occurred about a month after the injury and was accompanied by vertiginous attacks. Before he received his aural injury his hearing was perfect.

### EXAMINATION. 17.9.43.

*Right Ear.*—R.T.M. normal. Autoinflation +. Conversational voice 12 ft. Whispered voice 4-30 in. Watch 4-36 in. A.B.C. reduced 4 secs. Weber lateralized to right ear.

*Left Ear.* L.T.M. normal. Autoinflation +. Conversational voice 3 ft. Whispered voice 6-30 in. Watch not heard on contact Rinne + ve. A.B.C. decreased 12 secs.



## CASE 4. L/Bdr. S.

In April, 1940, this patient was in a concrete dug-out in France when a shell exploded at the entrance. He was not wounded, but noticed severe deafness and tinnitus, though there was no bleeding from the ears. At the end of a fortnight the hearing in the left ear had greatly improved but the right ear remained completely deaf.

# Injury to the Ears Among Battle Casualties

EXAMINATION. 22.9.43.

*Right Ear.*—R.T.M. shows some loss of lustre with poor inflation. Conversational voice 20 ft. Whispered voice 6-36 in. Watch not heard on contact. Rinne test shows almost complete loss of both air and bone conduction except for some sense of vibration with the latter.

*Left Ear.*—L.T.M. normal. Autoinflation +. Hearing and bone conduction tests completely normal.

None of these patients had any gross nasopharyngeal disease.

The interesting question arises as to how much of the deafness in these patients is psychological. Milligan and Westmacott (1915) and Hurst and Peters (1917) made an investigation into psychological deafness in the last war, but possibly overemphasized the frequency with which true hysterical deafness occurs. During two years' experience in the Middle East, I can only recall three patients whose deafness I felt certain was hysterical in origin. At the same time, I consider that there is frequently a psychological element which leads to an exaggeration of the symptoms caused by an underlying pathological lesion. The four patients whose examination is recorded were all non-commissioned or warrant officers. They had not come up for examination in the normal course of events, but had been sent 'up for investigation because at one time they had reported sick on account of their ears. The objects of the investigation and the importance of accurate replies were stressed before the examination started and my own impression was that there was not a great deal of psychological disturbance present. All the men seemed quite happy in the performance of their normal army duties and were of a very intelligent type. In three of the patients the deafness was of more than a year's duration and could be considered to be established. Except for Case 3 it is not considered that the military efficiency of these soldiers has been greatly impaired on account of their deafness, as unilateral deafness does not prove a big handicap in the Army nor does the loss of some of the higher tones. Colledge (1940) has raised the interesting point as to whether patients who sustain damage to the cochlea develop a progressive and early senile deafness. Opinion on this subject is divided and up to the present the aural records have not been full enough to supply an authoritative answer. The question is obviously one of importance in the allocation of pensions, but more information is necessary.

(b) *Blast Injury to the Vestibular Labyrinth.*—It is my opinion that the vestibular labyrinth is damaged by blast far more frequently than is imagined. If a patient is seen soon after he has sustained his aural injury, there will frequently be some spontaneous nystagmus and rombergism most marked to the side of the injured ear. In two patients, seen within ten minutes of being bombed, vomiting was also present, but it was difficult to dissociate this entirely from shock. Usually these



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labyrinthine symptoms disappear within two or three days, but I have seen two patients who were unable to lift their heads for over a week because of vertigo and nausea. Jones-Phillipson (1917) in the last war made the observation that frequently there was a disturbance of labyrinthine function in blast injury to the ears. He found that a greater amount of water was necessary to elicit any nystagmic response with the caloric test in these patients and apparently he carried out the test even though the tympanic membrane was ruptured, which we now know to be inadvisable. I have only had an opportunity of carrying out caloric tests in the four patients discussed under Blast Injury to the Auditory Labyrinth. I used the technique which has been elaborated by Fitzgerald and Hallpike (1942) and the following are the case histories and results :

### CASE 1. B.S.M.W.

*Symptoms and Signs.*—Occasionally the patient experiences some vertigo on quick movement of the head. The vertigo is unaccompanied by nausea or vomiting. No spontaneous nystagmus or rombergism is present.

*Caloric Test.*—Directional preponderance to the right, indicative of a left utricular paresis.

### CASE 2. Sergt. H.

*Signs and Symptoms.* The patient experiences no vertigo. No spontaneous nystagmus or rombergism is present.

*Caloric Test.*—Directional preponderance to the left, indicative of a right utricular paresis.

### CASE 3. B.S.M.D.

*Signs and Symptoms.*—The patient experienced no vertigo at the time of the injury but about a month later he started to have giddy turns. These attacks come on without warning. Everything seemed to spin round and the attack is accompanied by vomiting which may last five to six hours. The patient is never unconscious and has no incontinence of urine. The attacks vary in periodicity but they are getting more frequent. Since the attacks he has had tinnitus confined to the left ear. There is slight spontaneous nystagmus to the right and left with general unsteadiness.

*Caloric Test.*—Examination difficult, but apparently a bilateral paresis of the external semi-circular canals is present, worse on the left side.

### CASE 4. L/Bdr. S.

*Symptoms and Signs.* This patient experiences no vertigo. There is no spontaneous nystagmus or rombergism present.

*Caloric Test.*—Directional preponderance to the left, indicative of a right utricular paresis.

It will be noticed that this technique differentiates between paresis of the external semi-circular canal and a condition which is termed

## Injury to the Ears Among Battle Casualties

directional preponderance. This latter phenomenon is concerned with labyrinthine tone and such tonic impulses are probably situated in the utricle. The delayed onset of the labyrinthine symptoms in Case 3 is of interest. Although all these four patients have shown some disturbance of labyrinthine function, it is not suggested that this is a true indication of the frequency of labyrinthine involvement, but the results would indicate that the question of labyrinthine trauma in association with blast injury to the ears merits more detailed investigation than it has yet received.

### Prophylaxis

Prophylaxis can be directed along two lines. Firstly, the prevention of blast injuries and secondly, the avoidance of disabling sequelae, such as aural infection and residual deafness. The Army has recently issued an instruction that cotton wool must be applied to the canal of the ears as a form of local protection by all men in the Royal Artillery, Anti-Aircraft batteries and Anti-tank units. This is for protection from aural trauma caused by gun-fire. Aural injuries sustained by battle casualties are, however, more widely distributed over the whole of the Army and the effect on military efficiency from the use of cotton wool ear plugs among Infantry units might be worth a trial. Cotton wool gives a reasonably good protection from blast without interfering to any considerable extent with the hearing for commands. It is also suggested that a too great enthusiasm should not be displayed by medical officers for syringing soft wax out of a patient's ears, as ruptures of the tympanic membrane were seldom seen when soft wax plugs were present. A further form of local protection could be found by redesigning the steel helmet more along the lines of the German or American pattern with protection over the ears. The new assault type of steel helmet hardly meets these requirements. With regard to prevention of infection of the middle ear after a rupture of the tympanic membrane has occurred I would suggest that a necessary preliminary is a recognition of the incidence of this injury. In my opinion, all battle casualties evacuated to base should have their ears examined by an otologist and the results should be recorded on the Field Medical Card (A.F. 3118) or the Hospital Medical Card (I. 1220).

The examination should be made irrespective of whether the soldier complains of any aural symptoms and negative findings should be recorded. The question of whether to evacuate a soldier with a rupture of the tympanic membrane will sometimes prove a problem, though often the decision is made by the fact that the man has other wounds. The maintenance of front-line strength and the congestion along the lines of evacuation are both points which need consideration. Personally, when the battle started, I considered it justifiable to evacuate to base or rest

camp three classes of men whose only complaint was of aural injury. The first group were those men whose middle ear was already infected when they were examined and whose unit was so far forward that it was unlikely that they could receive adequate treatment or specialist supervision. The second group comprised the patients who had a considerable degree of concussion deafness of more than 48 hours' duration with or without a rupture of the tympanic membrane, and the third were mainly personnel of the Royal Artillery or Tank Corps who were liable to get repeated aural trauma.

### Treatment

I found the following methods of treatment of most value.

(a) *Blast Injury to the External Ear*.—Sulphanilamide powder and vaseline was applied. A sterile plug of cotton wool, which was frequently changed, was placed in the external auditory meatus.

(b) *Rupture of the Tympanic Membrane*.—(1) Dry traumatic perforations. A plug of sterile cotton wool was placed in the external meatus. Blood clot or wax was removed when necessary by direct vision with a small curette or wool applicator. Plugging, syringing or instillations were forbidden and personally I did not like the local application of sulphanilamide powder to prevent infection as it obscured the view on examination, and in my experience was not always successful in its object. A considerable number of these patients will receive some form of sulphanilamide by mouth as a routine if they are wounded in other parts of the body, and a recommendation that this general administration should cover all patients with a rupture of the tympanic membrane, irrespective of any other wounds, was made by the otologists in the Middle East. A small point, often forgotten, is to warn the patient against forcible blowing of the nose and the danger of getting water in the ear when washing. Bathing and swimming must be forbidden until the aural injury is healed.

(2) Traumatic perforation with slight serous discharge or an accompanying otitis externa. The meatal canal was mopped out with dry-sterile cotton wool twice daily and as a final application the meatal walls were painted with a cotton wool applicator squeezed out in spirit, care being taken to mop towards the external ear and not towards the tympanic membrane.

(3) Traumatic perforation with established purulent discharge. This was treated on the ordinary lines of an otitis media with carbolic acid or boric acid in spirit drops instilled after dry cleaning. At a later stage the insufflation of boric iodine powder was helpful.

(c) *Concussion Deafness*.—The treatment for this condition is rest and avoidance of any repeated trauma. Concussion deafness which persists after six months is likely to be permanent, but at the same time it is important to adopt an encouraging manner as there may often be a

# Injury to the Ears Among Battle Casualties

considerable psychological factor present. Tinnitus will prove a troublesome symptom and, if severe, luminal is probably the most effective remedy.

## Summary

(1) In this investigation of 885 battle casualties of all types, it was found that one in every five patients sustained some aural trauma, which was usually due to blast. The unit distribution of the patients and the types of battle casualty affected are shown in addition to the type of missile which caused the injuries.

(2) In the majority of patients the aural injury consisted of a rupture of the tympanic membrane, which was accompanied by an initial mixed inner- and middle-ear deafness in about 40 per cent. of the patients with traumatic perforations. The percentage of patients with rupture of the tympanic membrane who are left with residual deafness is undetermined, but is not considered to be negligible.

(3) The effect of blast on the anatomical parts of the ear is discussed. Twenty-two per cent. of the traumatic perforations became infected.

(4) Some observations are made on prophylaxis and the forms of treatment which proved of value.

In conclusion I should like to thank Colonel R. D. Davy and Colonel H. D. F. Brand for their encouragement in this investigation.

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# A COMPARATIVE REPORT ON EAR, NOSE AND THROAT WORK IN THE ARMY AT HOME AND OVERSEAS

By T/MAJOR J. F. BIRRELL, R.A.M.C. (Edinburgh)

FOLLOWING the example set by Craig<sup>1</sup> (1941) I have kept accurate notes of all cases examined and treated during service as an Army E.N.T. Specialist in a Military Hospital at home and a General Hospital working with the British North African Force. This report was originally intended to be a comparison between my two sets of figures, but since then Collins<sup>2</sup> (1943) and Reeves<sup>3</sup> (1943) have published their accounts of work done with the Middle East Force. I propose, therefore, to divide the article into four parts, (i) a general consideration of the difficulties met with in field conditions, (ii) a comparison between my first thousand cases seen at home and in North Africa, (iii) a brief synopsis of the total work done while with the B.N.A.F., and (iv) a correlation of my figures with those of Craig, Reeves and Collins.

## General Considerations

The change from hospital work in buildings at home to work in tents on an exposed plateau, some 3,000 feet above sea level, in North Africa, is very marked, and is apt to take one by surprise. The amenities which one had been accustomed to take for granted at home—ease of lighting, running water, ease of cleanliness both personal and departmental, protection from heat, cold, wind and rain—all are lacking when working under canvas.

For the first month in North Africa my E.N.T. department had no out-patient tent, and such patients as arrived for examination were seen in a screened-off corner of a 24-bedded ward. This, naturally, proved a most unsatisfactory arrangement, and the E.N.T. and Eye departments at last secured a small marquee (28 ft. by 14 ft.) for an out-patient department. As the out-patient hours were the same, the tent was partitioned off, by means of a tent wall, into one-quarter and three-quarters. This division was arrived at by mutual agreement, and the ophthalmic specialist occupied the larger part in virtue of his need of 20 feet for testing vision.

The E.N.T. section was small but compact, and thus well suited to deal with large numbers of out-patients with the minimum of delay. The lay-out was kept as simple as possible. A long table running

## Comparative Report on Ear, Nose and Throat Work

alongside the division wall took the examination lamp, drugs for out-patient treatment, examination instruments, and jars containing small packets of sterile wool and ribbon gauze each sufficient for one day's work. A smaller table, also against the partition, held a file for case notes, various Army forms, and X-rays, while the remainder of the instruments were kept in a bedside locker set against the shorter partition wall.

The drugs used were those available for adequate out-patient treatment: 10% cocaine hydrochloride, adrenaline hydrochloride, 1%, 10% and 25% silver nitrate, various ichthammol preparations, 1% aqueous and 1% alcoholic gentian violet, chromic acid crystals, iodine in boric powder and rectified spirit. The instruments supplied were sufficient for all ordinary examinations, though I felt the lack of a Vienna tuning fork and a Barany noise box in certain cases. The deficiencies in instruments and drugs at home could be made good by using one's own instruments and by local purchase of drugs, but in North Africa, 45 miles from the nearest town, no such facilities existed. An unexpected problem was set by flies swarming round dirty wool that had been used for mopping ears. This was overcome by punching a hole in the top of a tobacco tin, smearing the lid with cresol, and half-filling the tin with weak lysol solution. The used gauze packs and wool were dropped in through the lid and the flies stopped swarming. The same weak lysol solution was used to clean instruments between cases in preference to a sterilizer, heated by methylated spirit lamps, which was considered unsafe in a tent.

Treatment was carried out personally each day, and every case was treated until fit for duty, or until he could be evacuated to the base for transmission to England. This meant that most aural cases were seen daily purely for dressing purposes, and the total number of daily attendances was thus far in excess of the total number of new cases. Such a policy did not meet with the approval of any of my ward sisters, who each complained that they had not enough work to do. The results obtained, however, convinced me that the procedure was fully justified. Aural cases healed more quickly than had been my experience in hospitals where the daily treatment was left to the nurses with only an occasional examination by the specialist.

A card-index file was kept of each new case seen as an out-patient, in-patient in my ward, or elsewhere in the hospital, and a book, indexed under diseases, has proved most useful for various returns and reports. The notes on cases and replies to Medical Officers, the case sheets for in-patients and the various pathological and X-ray forms were all written personally as no junior officer was attached to the department. Yet the compactness of the department made it possible to deal with 50 or 60 cases before lunchtime. On the busiest day 84 out-patients were seen before tea, and of these 65 were new cases. During the six months in

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which the out-patient department was functioning 943 cases, involving 3,970 attendances, were examined and treated.

## Figures at Home and Overseas

The first thousand cases examined in the Military Hospital at home and in the General Hospital overseas include all cases seen as out-patients, in the E.N.T. ward or in other wards. For convenience these will be dealt with under separate headings. The general figures are :

	Home.	Overseas.
Diseases of the Ear .. ..	563	662
Diseases of the Nose .. ..	269	187
Diseases of the Pharynx .. ..	113	84
Diseases of the Larynx, etc. ..	22	22
Negative examinations .. ..	33	45
	<hr/>	<hr/>
	1,000	1,000
	<hr/>	<hr/>

## DISEASES OF THE EAR.

In either hospital, aural cases have provided more than half the total number of patients seen : 56·3 per cent. at home and 66·2 per cent. overseas. A detailed comparison of all aural cases would be too long for one table, and they have been subdivided into affections of the external ear, middle-ear conditions, and other aural cases.

<i>Affections of the External Ear.</i>	Home.	Overseas.
Cerumen .. ..	19	34
Otitis externa .. ..	112	192
Furuncle of external meatus ..	6	19
Dermatitis of auricle .. ..	5	6
Osteoma .. ..	8	6
Foreign body .. ..	2	3
Keratosis obturans .. ..	1	3
	<hr/>	<hr/>
Total .. ..	153	263
	<hr/>	<hr/>

From these figures it will be seen that affections of the external ear comprise 20·7 per cent. of all cases seen, or 33·6 per cent. of all aural cases.

Otitis externa alone accounts for 24·8 per cent. of aural conditions or 15·2 per cent. of all cases. Relatively there has been much more otitis externa in North Africa than in England. This is only to be expected when one considers the various physical factors concerned in the ætiology of the condition, which are experienced in Algeria : the greater heat and perspiration, the sirocco with its dust storms, the relatively greater amount of sea-bathing indulged in by the troops.

## Comparative Report on Ear, Nose and Throat Work

the dirty conditions of the sea as a result of the native habit of disposing of refuse by tipping it into the sea, and the difficulty in obtaining early treatment during the battle. Daggett<sup>†</sup> (1942) was of the opinion that sea-bathing had little effect in the production of otitis externa in the cases he examined in Malta. Of the 104 cases which he reviews, 76 were non-swimmers, or had not been swimming for two or more weeks prior to the onset of symptoms. My experience has been different. The marked increase in the number of cases of both otitis externa and acute otitis media occurring in soldiers who had been in rest camps at the coast after the successful termination of the Tunisian campaign leaves no doubt in my mind of the prominent part played by sea-bathing in the ætiology of the condition. In fact, those cases who had been bathing often showed within a few days a most acute variety of the condition with much œdema and a membrane formation in the inner half of the meatus. This observation agrees with Daggett's view that "a little highly concentrated sea water may be left in the depths of the meatus, so that by evaporation a thin film of pure salt could collect. This might, by hygroscopic action, tend to increase skin maceration".

Treatment of this condition presented considerable difficulties. In many cases it had been misdiagnosed by unit medical officers as chronic otitis media, and treated as such. The most common practices, were to instil either hydrogen peroxide, or carbolic in glycerine drops, neither of which produced any benefit in the local condition. Both the carbolic and the peroxide tend to macerate the skin, and allow the disease to spread and involve the auricle or skin of the face.

The otitis externa was seen in all its varieties, acute œdematous, subacute and chronic. In civilian practice it was my custom to reduce the œdema with 8% aluminium acetate, go on to 10% ichthyol in glycerine, and finish up by painting the meatus with spirit or with 1% alcoholic gentian violet. The Army does not supply aluminium acetate, and I was not as fortunate as Daggett in obtaining a supply locally. In England, too, glycerine was difficult to obtain, and some means of reducing œdema had to be found. A 10% ichthammol in water was not effective, so I had ichthammol made up to 10 per cent. in hypertonic saline. This forms a suspension which must be shaken before being used. I have been impressed with the speed with which œdema disappears and inflammation settles when cases are treated thus. Indeed, one found in a number of cases that the otitis media dried up as well. Bearing this in mind several patients with acute otitis media and perforated drums have been treated with the drug with good results. The important factor in the treatment, as Daggett and Collins have emphasized, has been the accurate daily mopping of the meatus, especially the anterior recess, before the ribbon gauze pack is inserted. I have attempted to treat some cases of otitis externa by mopping alone, but this has not proved successful. The most



resistant cases to this type of treatment have been those with membrane formation in the bony meatus.

*Affections of the Middle Ear.*

			Home.	Overseas.
Acute catarrhal otitis media	..	..	17	17
Chronic catarrhal otitis media	..	..	97	43
Acute suppurative otitis media	..	..	20	73
Chronic suppurative otitis media—safe	..	..	175	83
Chronic suppurative otitis media—unsafe			70	79
Traumatic affections of the ear	..	..	6	58
Total .. .. .			385	353

The number of middle-ear conditions represents 36.9 per cent. of all cases, or 60.2 per cent. of aural cases.

Chronic catarrhal otitis media is taken to include all patients who have a middle-ear deafness with stenosed Eustachian tube, or with indrawn fixed drums. No cases of otosclerosis were seen.

The "safe" chronic otitis media cases are those with a perforation which is anterior, central or posterior provided that the drum margin is not involved. The "unsafe" cases are those with a postero-marginal, postero-superior or attic perforation, or who show granulations, polypus or cholesteatoma where the exact site of the perforation may not have been determined. The relative proportions are :

					Home.	Overseas.
Polypus or granulations	..	..	..	..	17	12
Cholesteatoma	..	..	..	..	6	3
Attic suppuration	..	..	..	..	9	21
Postero-marginal or postero-superior perforation					11	32
Old unhealed radical mastoid cavities	..	..	..	..	25	9
Acute exacerbations of chronic otitis	..	..	..	..	2	2
Total .. .. .					70	79

Such cases are unfit for active service overseas, and are usually not sent out of England. The large number seen in North Africa was a surprise to me, and my first reaction was that little or no interest had been taken by the unit medical officer in the man's aural condition before embarkation. Indeed, many patients acknowledged that their ears had not been examined before they left for Africa. On the other hand, quite a number had been overhauled by their M.O. Analysis shows that the increase lies in those patients with a postero-marginal, postero-superior or attic perforation. These men often have good hearing, and the harassed unit medical officer, checking over his unit before embarkation, is apt to rely too much on the hearing standard required by the Army for high

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categories. A man need only be able to hear a whisper at 10 feet using both ears, when standing with his back to the examiner, to qualify for overseas service.

Under the term traumatic affections of the ear are classified concussion deafness, hæmorrhage in the drum without perforation, dry perforation due to blast, and otitis media secondary to blast. The proportions met with in North Africa were :

Concussion deafness	..	..	..	16
Drum hæmorrhage	..	..	..	9
Blast perforation	..	..	..	20
Blast otitis media	..	..	..	13
				—
				58
				—

In each case of blast otitis media a history was obtained of the ear having been syringed, or of drops having been instilled. It is justifiable, however, to assume that some cases with a pre-existing otitis externa might develop an otitis media from a direct spread of infection in the absence of any exciting factor. Recently, a number of patients have been seen in whom this has taken place. The blast otitis media cases have been treated along the usual lines.

One is frequently asked what percentage of battle casualties exhibit aural damage, and the suggestion has been made that many cases are "missed" during evacuation of the patient to the base. During the Tunisian campaign the ears of 276 patients in the surgical wards of the hospital were investigated one day. Of the 552 ears thus examined eleven were found to show conditions that could be ascribed to blast. These occurred in eight patients (2.89 per cent.). The land-mine was responsible for seven of the ears (four cases), and of these the aural condition was the only injury in six ears (three cases). In addition to the above, two patients showed concussion deafness. Not one of these cases had been "missed" in our hospital as I had been asked to see each one by the medical officer of the ward concerned, although he had no previous knowledge of the investigation. Our hospital was situated far back from the line, and it is probable that a much higher percentage of damaged ears would be found in hospitals further forward.

While speaking of discharging ears mention must be made of the very common, and, to my mind, wrong habit of insufflating sulphanilamide powder into discharging ears. If such an insufflation is carried out after the ear has been mopped clean under vision, and if only a fine film of powder is applied by means of an aural insufflator, good results might be obtained. From my experience of the results of this treatment by unit medical officers it is apparent that many ears have not been completely

# J. F. Birrell

resistant cases to this type of treatment have been those with membrane formation in the bony meatus.

## *Affections of the Middle Ear.*

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The relatively larger number of cases of deviated septum seen at home may be explained by the fact that during the initial period of training respirator drill, etc., the recruit is increasingly conscious of minor defects, or asymmetry of nasal airway

Fifteen cases of nasal polypi were seen in England as compared with only two in North Africa. This is an indication that these cases were not being sent overseas, where they do badly

A sudden drop in the temperature in Algeria accounted for seventeen of the twenty-five cases of acute sinusitis met with in that country

The lack of vegetation and therefore pollen, in the high plateaux of North Africa explains the absence of cases of hay fever encountered. All the allergic cases seen overseas were of the vasomotor rhinitis variety in patients who presumably exhibited a polyvalent sensitivity. Very few grossly allergic noses were seen overseas and many patients who had suffered for years at home reported that they had been free from symptoms since coming overseas. Such cases present considerable difficulty in treatment. Zinc ionisation, which one<sup>s</sup> has found of considerable benefit at home is not possible under service conditions, and one hesitates to use the cautery too freely. The majority of my patients were told what was the matter, advised to put up with the discomfort, and recommended to have their allergy attended to after the war.

The relative figures show that there is a greater tendency for a dry nose in North Africa probably due to the low humidity and dust laden atmosphere

Amongst the miscellaneous cases an early leontiasis and a case of secondarily infected gumma of the septum with frontal sinusitis and orbital abscess are worthy of mention. Both were seen in England

## DISEASES OF THE PHARYNX

	Home	Overseas
Acute tonsillitis	3	12
Acute pharyngitis	2	5
Peritonsillar abscess	1	3
Chronic tonsillitis	88	47
Chronic pharyngitis	6	8
Miscellaneous	13	9
Total	113	84

The small number of cases of acute infections seen is due to the fact that, in each hospital, these were sent direct to an isolation ward under the care of the physicians, and I was only called in for a second opinion

Relatively few cases of chronic tonsillitis were referred to me in North Africa for an opinion regarding operation mainly because I felt that the combination of a tented hospital on an exposed plateau, a

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sirocco with its dust, and a theatre used extensively by the general surgeons for septic surgery made an unfavourable trio for recovery from tonsillectomy. The medical officers of neighbouring units realized the difficulties and sent these cases to another hospital situated in a building.

Amongst the miscellaneous cases was a malignant growth of the nasopharynx which was recommended for air evacuation to England for radiotherapy.

## DISEASES OF THE LARYNX, ETC.

In this section the totals are exactly the same, and the classification requires no comment. The functional aphonia in England were all A.T.S. personnel.

					Home.	Overseas.
Acute laryngitis	..	..	..	..	3	7
Chronic laryngitis	..	..	..	..	4	7
Tuberculous laryngitis	..	..	..	..	2	1
Syphilitic laryngitis	..	..	..	..	1	2
Papilloma of larynx	..	..	..	..	1	1
Functional aphonia	..	..	..	..	3	1
Diseases of bronchi	..	..	..	..	4	1
Diseases of œsophagus	..	..	..	..	2	—
Miscellaneous	..	..	..	..	2	2
					—	—
Total	..	..	..	..	22	22
					—	—

## OPERATIONS.

The number of operations performed in England was not large (17·5 per cent.). Cases were not operated upon without due cause, and it was quickly appreciated that a soldier who is not anxious to have something done for him is a poor subject for surgery. I was impressed by the few acute mastoids that were encountered, and by the fact that no paracentesis had to be performed.

In North Africa the number of operations (4·8 per cent.) was limited by two things, the exposed hospital site, dust storms and septic theatre, and the limited instruments available. At home one overcame the latter difficulty by using one's own set. The instruments that I missed most were a back-cutting antral punch of the Ostrom type, and a full set of mastoid gouges. I feel that three gouges and no Volkmann's spoon is a poor equipment for mastoid surgery if any degree of accuracy is to be attained. Also, when the gouges become blunt, too long a time elapses before they can be replaced.

The policy in Africa was to send home all chronic suppurative otitis media cases which were unlikely to heal, and it was with considerable regret that many cases, eminently suitable for the modified radical mastoid operation, were sent to England.

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The lack of a back-cutting punch meant that the intranasal antrostomy was an unsatisfactory operation, and, as a result, chronic maxillary sinusitis cases were all treated by a Caldwell-Luc approach. The two intranasal operations were for simple drainage in battle casualties.

The most interesting operation in Africa was a mastoid with temporal lobe abscess, while at home two cases of lateral sinus thrombosis were operated upon the same morning.

	Home.	Overseas.
Tonsillectomy .. .. .	54	5
Submucous resection of septum .. ..	42	2
Caldwell-Luc .. .. .	16	16
Intranasal antrostomy .. .. .	13	2
Cautery of allergic areas .. .. .	11	—
Removal of nasal polypi .. .. .	6	1
Reduction of fractured nose .. .. .	2	2
Frontal sinus operation .. .. .	1	—
Turbinectomy .. .. .	1	1
Removal of aural polypus .. .. .	7	—
Paracentesis .. .. .	—	1
Cortical (Schwartz) mastoidectomy .. ..	5	11
Modified radical mastoidectomy .. ..	4	1
Radical mastoidectomy .. .. .	2	1
Laryngoscopy .. .. .	2	2
Bronchoscopy .. .. .	4	—
Œsophagoscopy .. .. .	1	—
Miscellaneous .. .. .	4	3
	<u>175</u>	<u>48</u>

In the whole series there was one death which occurred in a patient who had a Caldwell-Luc operation for maxillary sinusitis and asthma. He died from hæmorrhage into the lungs after operation, and never came round from his anæsthetic.

## Synopsis of Total Work in North Africa

The total work in North Africa can best be summarized in the following Tables :

	OUT-PATIENTS.				IN-PATIENTS	
	New	% of New	Total	% of Total	Total	% of Total
Ear .. .. .	610	64.69	3,240	81.61	242	71.60
Nose .. .. .	174	18.45	501	12.62	62	18.34
Pharynx .. .. .	84	8.91	137	3.45	12	3.55
Miscellaneous .. .. .	75	7.95	92	2.32	22	6.51
Total .. .. .	943	100.00	3,970	100.00	338	100.00

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	CONSULTATIONS.				OPERATIONS.	
	New.	% of new.	Total.	% of Total.	Total	% of Total.
Ear .. ..	89	56.33	260	65.99	25	39.06
Nose .. ..	23	14.56	57	14.47	31	48.44
Pharynx ..	28	17.72	59	14.97	5	7.81
Miscellaneous ..	18	11.39	18	4.57	3	4.69
Total . . .	158	100.00	394	100.00	64	100.00

## Correlation with Other Authors

Two other authors, Craig and Reeves, have reported their figures of the first thousand cases examined, Craig's figures being taken from a military hospital at home, and Reeves' with the Middle East Force. It seemed to me that it might not be without interest to tabulate my figures with theirs and examine the results. This was not altogether an easy task as differences in diagnosis occurred. For example, Craig includes twenty-two cases of Eustachian catarrh in his nasal figures while I have classified them as aural. Again, Craig only shows "infected tonsils" and chronic pharyngitis under his pharyngeal group while I have subdivided them further. Reeves has many cases, which I have called miscellaneous, among his pharyngeal group. An endeavour has been made to correlate them in Tables I, II, III, IV and V.

TABLE I.

	HOME.		OVERSEAS.	
	Birrell.	Craig.	B.N.A.F. Birrell.	M.E.F. Reeves.
EAR				
Cerumen	19	25	34	52
Otitis externa .. ..	112	34	192	73
Furuncle of meatus .. .	6	17	19	—
Dermatitis of auricle ..	5	—	6	—
Osteoma of meatus .. .	8	—	6	—
Foreign bodies .. ..	2	3	3	—
Keratoses obturans .. .	1	—	3	—
Wound of auricle .. .	—	—	2	2
Sebaceous cyst .. ..	—	2	—	1
Hæmatoma or perichondritis ..	1	1	—	2
Acute catarrhal otitis media ..	17	56	17	170
Acute suppurative otitis media	20		73	
Chronic catarrhal otitis media	97	70	43	42
Otosclerosis .. ..	—	37	—	11
C.S.O.M.—safe .. ..	175	243	83	174
C.S.O.M.—unsafe .. ..	70		79	
Concussion deafness .. .	2	—	16	—
Hæmorrhage of drum .. .	5	—	9	—
Traumatic perforation .. .	1	—	20	4
Traumatic otitis media ..	—	—	13	—
Ménière's disease .. ..	7	—	5	—
Nerve deafness .. ..	10	14	18	13
Mixed deafness .. ..	—	—	15	—
Simulated deafness .. .	3	1	2	2
Miscellaneous .. ..	2	—	4	9
Total .. ..	563	503	662	555

# Comparative Report on Ear, Nose and Throat Work

TABLE II

	HOME		OVERSEAS	
	Birrell	Craig	B N A F Birrell	M E F Reeves
NOSE				
Epistaxis ..	11	33	19	—
Dermatitis of vestibule	2	—	7	6
Furuncle of vestibule ..	—	—	2	3
Septal Hæmatoma or abscess .. ..	2	—	1	2
Septal perforation ..	2	—	—	2
Septal ulcer .. ..	—	—	—	16
Deviated septum ..	63	72	23	27
Fractured Nose .				
Recent .. ..	4	} 8	4	} 8
Old .. ..	8		—	
Fractured ethmoid ..	2	—	—	—
Acute rhinitis .. ..	4	—	3	9
Chronic rhinitis ..	10	—	5	—
Fibrinous rhinitis ..	—	—	—	4
Hypertrophic rhinitis ..	11	8	2	14
Atrophic rhinitis ..	8	2	11	—
Ozæna .. ..	1	—	2	—
Rhinitis sicca .. ..	1	—	2	—
Allergic rhinitis ..	54	—	33	1
Acute sinusitis:				
Maxillary .. ..	10	} 8	19	7
Frontal .. ..	6			
Pansinusitis .. ..	2			
Chronic sinusitis .				
Maxillary .. ..	43	} 51	31	18
Frontal .. ..	2			
Pansinusitis .. ..	6			
Polyp (including choanal)	15	15	2	9
Miscellaneous .. ..	2	22*	5	10
Total ..	269	300	187	180

\* These 22 cases are all Eustachian catarrh

TABLE III.

	HOME		OVERSEAS	
	Birrell	Craig	B N A F Birrell	M E F Reeves
PHARYNX				
Acute tonsillitis ..	3	} 102	12	26
Acute pharyngitis ..	2		5	3
Peritonsillar abscess ..	1		3	—
Chronic tonsillitis ..	88	} 5	47	58
Chronic pharyngitis ..	6		8	—
Vincent's infection ..	8		—	—
Glandular fever ..	2	—	—	—
Syphilis .. ..	1	—	—	1
Ulcer of tonsil ..	1	—	2	—
Diphtheria .. ..	—	—	3	—
Keratosis pharyngis	—	—	—	1
Carcinoma nasopharynx	—	—	1	—
Sarcoma of tonsil ..	—	—	—	1
Miscellaneous .. ..	1	—	3	1
Total ..	113	107	84	91



# J. F. Birrell

TABLE IV.  
HOME.

	Birrell.	Craig.	B.N.A.F. Birrell.	OVERSEAS. M.E.F. Reeves.
LARYNX				
Acute laryngitis ..	3	} 21	7	39
Chronic laryngitis ..	4		7	
Tuberculous laryngitis	2		1	5
Syphilitic laryngitis ..	1		2	4
Functional aphonia ..	3		1	3
Papilloma vocal cord	1		1	1
Laryngeal diphtheria	1		—	—
Miscellaneous .. ..	1	1	2	2
Total ..	16	22	21	54

TABLE V.

	Birrell.	Craig.	B.N.A.F. Birrell.	OVERSEAS. M.E.F. Reeves.
TRACHEA BRONCHI OESOPH.				
Tracheitis .. ..	—	—	1	2
Hæmoptysis .. ..	4	—	—	—
Carcinoma of lung ..	—	—	—	2
Upper and œsophageal spasm .. ..	1	—	—	—
Foreign body in œso- phagus .. ..	1	—	—	—
Carcinoma of œsophagus	—	1	—	—
Total ..	6	1	1	4
Miscellaneous .. ..	—	—	—	22
Negative examination ..	33	67	45	94

The other author who has made a report on E.N.T. work in the Middle East is Collins (1943), but his figures do not cover a thousand cases. Instead, he gives percentages of the most commonly occurring conditions which he found to be acute tonsillitis, otitis media, otitis externa and sinusitis. He also quotes the figures for deflected septum. These can all be correlated with the exception of the pharyngeal cases where there is no comparable classification. In order to arrive at the figures for sinus infection I have taken those of acute and chronic sinusitis and nasal polypi together. The results appear in Table VI.

## EAR.

### Discussion on these Figures

Relatively speaking a higher proportion of aural cases are seen overseas than at home. This increase is accounted for by three conditions—otitis externa, acute otitis media and traumatic affections of the ear. The reasons for this have already been mentioned, and require no further elaboration.

There is a marked similarity in the numbers of chronic otitis media cases at home (Birrell 245 and Craig 243) and overseas (Birrell 162 and Reeves 174). The drop in the number seen in Africa would indicate that

TABLE VI

	% of Cases of the part concerned					% of Total Cases Reported.				
	HOME		OVERSEAS.			HOME		OVERSEAS		
	Birrell	Craig	Birrell	Reeves	Collins	Birrell	Craig	Birrell	Reeves	Collins
Otitis externa . .	19.89	6.78	29.00	13.15	34.40	11.20	3.40	19.20	7.30	16.05
Acute otitis media . .	6.57	11.13	13.59	30.65	7.03	3.70	5.60	9.00	17.00	3.48
Chronic otitis media . .	43.52	58.75	24.47	31.35	27.73	24.50	24.30	16.20	17.40	13.73
Deflected septum . .	23.49	24.00	12.30	15.00	12.65	6.30	7.20	2.30	2.70	4.06
Sinus infection . .	31.60	51.66	36.36	43.33	66.87	8.40	15.50	6.80	7.80	20.31

# CLINICAL RECORD

## SARCOMA OF THE MIDDLE EAR AND MASTOID

By A. C. MACONIE (Windsor)

SARCOMA of the middle ear and mastoid appears to be a condition of considerable rarity. Thus, in two series of 38 and 70 malignant tumours in this region, only 3 and 2 cases respectively are recorded.

Sarcoma in children provides a very small proportion of the total figures.

### Survey of the Literature

Figi and Hempstead, of the Mayo Clinic, in 1943 reported 38 malignant tumours of the middle ear and mastoid process, of which 3 were sarcomatous in nature, and affected patients aged respectively 55, 28 and 3. The latter was treated by radical mastoidectomy, diathermy and irradiation, and died three months after operation. Histologically the growth was found to be a neuro-fibro-sarcoma.

Philip Scott analysed 70 cases of malignant disease of the ear, excluding the pinna, in a paper before the Section of Otology of the Royal Society of Medicine in 1939, and of these recorded only 2 sarcomata, in patients aged 48 and 51.

Ivan Thorell, of the Radiumhemmet, Stockholm, in 1935 described 13 middle-ear tumours, comprising 11 instances of carcinoma, 1 of malignant melanoma, and 1 of sarcoma of the dura, invading the middle ear.

The last case occurred in a male *æ*t. 42. The external auditory meatus was filled with polypoid masses, which had penetrated the posterior wall of the canal. At operation, the mastoid process proved to be partly filled with soft greyish-white tumour masses, arising from an area about 3 cm. in diameter on the dura of the posterior cranial fossa. The posterior wall of the auditory canal was destroyed, the middle ear was filled with tumour, and the bony labyrinth partially eroded. Radium application to the wound cavity for twelve hours, followed by repeated telerradiation, resulted in complete healing with no recurrence nine years after the operation.

Lionel Colledge (1943) records an example of spindle-celled sarcoma of the temporal bone in a female child aged 6. The tumour was situated in the region of the right parotid, invading the base of the skull, the temporal, sphenoidal and ethmoid bones, and projecting into the nasopharynx.

J. L. Zimmerman in 1933 described a case of Ewing's sarcoma of the mastoid in a child of 5. A radical mastoid operation was performed, and the cortex was found to be a thin shell of bone, riddled with holes. The interior of the mastoid contained no bony structure whatever, but was replaced by a friable, waxy, greyish-pink tissue, which bled freely. Post-operative treatment consisted of radium application and deep X-ray therapy, but a fatal result followed eight months after the first appearance of symptoms.





# Clinical Record

Portmann and Despons (1934) report an instance of neuro-sarcoma involving the mastoid of a girl of 13.

Wilson and Windeyer, in a discussion held at the Royal Society of Medicine in January, 1944, advocated radio-therapy as a *preliminary* to radical operation, in contradistinction to the more usual post-operative employment of radiation.

## Report of Sarcoma in boy of 5

The patient, a healthy looking boy aged 5, was admitted to King Edward VII Hospital, Windsor, on October 6th, 1943, at the request of Dr. F. G. Leslie.

Right otorrhœa had been present for a fortnight, and one week previous to admission a polypoid mass was observed occluding the right external auditory meatus. The child had made no complaint of pain until the evening of October 5th, and his father, an intelligent man, was emphatic that there had been no previous aural pain or discharge and that the hearing had never been appreciably impaired.

On examination, a large reddish-brown polypus was seen projecting from the right external auditory meatus, and on October 7th weakness of the muscles of the right side of the face was noted. Pain and tenderness were absent at this time, and the temperature was not elevated.

The polypus was removed through the external auditory meatus, under general anæsthesia.

On October 8th, the facial paresis was more pronounced and the temperature 100°. A right radical mastoidectomy was therefore performed.

At operation, the cortex of the mastoid process was eroded, and polypoid masses protruded through the bone. The use of a mallet and gouge was not necessary, the bone being so softened that clearance of the mastoid cavity was carried out by means of a sharp spoon.

Destruction of bone was very pronounced and a large portion of the posterior meatal wall had disintegrated. The mastoid and the middle ear were completely filled with polypoid material.

On October 22nd, profuse hæmorrhage occurred from the external auditory meatus, associated with considerable post-auricular swelling and forward displacement of the ear. The incision was therefore reopened on October 23rd, and the whole radical cavity found to be filled with a most profuse over-growth of greyish-white tissue, obviously of neoplastic origin.

Microscopical examination of the aural polypus, and of tissue removed from the mastoid and middle ear at each of the subsequent operations, showed a spindle-celled sarcoma in all three specimens.

In the first the histology was obscured by much hæmorrhage and œdema, and the tissue also contained a very large number of polymorphs.

In the second and third preparations, the sarcomatous nature of the growth was much more evident, the sections showing an active spindle-celled tumour.

Deep X-ray therapy was instituted by Mr. Carter Braine, and between November 2nd and December 7th, 1943, a total dose of 5,000 "r" units was given to the post-auricular area, K.V.180 Pulsating, 40 cm. distance and filtration 0.5 Cu. + 1.0 Al.

## A. C. Maconie

During the X-ray treatment complete paralysis of the right external rectus muscle of the eye developed, presumably due to progression of the neoplastic process inwards to the apex of the petrous part of the temporal bone and involvement of the VIth cranial nerve in this situation. The facial palsy persisted.

On December 13th, the post-auricular wound was almost healed and there was no projection above the surrounding skin surface. Fungating granulations, however, soon appeared and rapidly grew to form a tumour of remarkably large dimensions, and the child died on February 11th, 1944. Repeated injections of morphia had been necessary for the control of pain.

The duration of the illness, from the onset of symptoms until death, had been  $4\frac{1}{2}$  months.

### Post-mortem Examination

This was performed by Dr. E. Sayle on February 11th, 1944; the temporal bone and adjacent diseased structures were removed *en bloc*, and are now in the Museum of the Royal College of Surgeons.

A photograph of the specimen, taken by Mr. Smart from the lateral and posterior aspects immediately after removal and before fixation, are appended.

Dr. Sayle's report reads as follows:

"No general examination was made, at the relatives' request.

"There was a large fungating tumour behind the right ear, which had pushed the auricle downwards and forwards. A small polypoidal mass of a similar character was just protruding from the external auditory meatus.

"On dissection the neoplasm was found to extend forwards below the ramus of the mandible to the submaxillary salivary gland, and inwards, behind the mandible, to the lateral pharyngeal wall, which was pushed medially.

"Within the skull the growth extended upwards beneath the dura into the middle fossa, above the petrous part of the temporal bone. This upward extension had produced compression of the temporo-sphenoidal lobe, but there was no evidence of infiltration.

"Further extension medially had carried the growth across the basilar part of the occipital bone to the opposite side.

"A small secondary nodule was present on the outer aspect of the coronal suture over the vertex on the left side.

"No further dissection was made as the specimen was sent *in toto* to the Royal College of Surgeons.

"During life microscopical examination of fragments of polypi showed these to be parts of a spindle-celled sarcoma, an opinion independently confirmed by Professor G. W. Nicholson and Dr. E. ff. Creed.

"While the exact site of origin of the growth was not determined for the reason given above, it was concluded from the clinical history that this was a sarcoma arising in the middle ear and mastoid."

### Summary

A case of spindle-celled sarcoma of the middle ear and mastoid of a boy of 5 is reported. The protrusion of a polypus from the external auditory meatus was the first sign of disease noted.

# Clinical Record

Radical mastoidectomy, followed by deep X-ray therapy, resulted in temporary improvement, but the neoplasm rapidly recurred and death occurred 4½ months after the initial onset of symptoms.

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## CLINICAL NOTE

### SKIN GRAFTING IN FRONTAL SINUS OPERATIONS

By W. H. BRADBEER (Torquay)

PERSONAL experience with conservative external operations for chronic frontal sinusitis has been disappointing, and it is believed that others have found the results unsatisfactory. Although a satisfactory fronto-nasal opening is present for the first few weeks after operation post-operative scarring leads to stenosis and recurrence of symptoms. On several occasions it has been necessary to perform an obliterative operation to achieve a cure.

A skin graft to the new opening would appear to offer a solution to the problem, but if the external wound is closed at the time of operation it is difficult to ensure good apposition of the graft and to be certain that it has taken. The technique followed below has proved so successful on a case operated on last December that it is described in the hope that others may give the method a trial.

15.12.43. Miss M.H., æt. 33, was referred to the O.P. department complaining of very severe left frontal headaches of fourteen days' duration, and some years' history of chronic nasal catarrh. Examination of the nose showed a small polypus under the anterior end of the left middle turbinal. No pus was visible in the nasal cavity, but the left frontal sinus was dull to trans-illumination and X-rays. In view of the history of chronic disease, it was felt that conservative treatment would be of no help and operation was advised.

21.12.43. An external operation was performed, following Howarth's method, with exenteration of the anterior ethmoidal cells. The frontal sinus contained pus under pressure and a thickened polypoid mucosa was removed as far as possible. The operation cavity was dusted lightly with sulphanilamide powder and packed with gauze soaked in saline, while a skin graft about  $4\frac{1}{2}$  in. by  $1\frac{1}{2}$  in. was cut from the inner aspect of the thigh. The graft was first applied to the nasal side of the opening and held in position with tulle gras. A rubber drainage tube of convenient size was inserted from the frontal sinus to the nostril and the cavity lightly packed with more tulle gras. The free portion of the skin graft was then turned laterally over the packing and tucked in on the orbital side of the cavity. The skin graft was then divided vertically with a fine pair of scissors, and the two edges turned outwards and trimmed flush with the margins of the skin incision. Further tulle gras was packed in and the skin wound left unsutured. The end result of these manœuvres was that there were two skin grafts, one on the nasal side and one on the orbital side of the cavity, held in place by tulle gras packing containing a drainage tube. The wound remained very clean, with very little discharge.

## Clinical Note

28.12.43. Seven days later, under pentothal anæsthèsia, the packing and tube were removed. Redundant and sloughed portions of the graft were removed. A satisfactory take had occurred and the skin edges were freshened and sutured.

4.1.44. The skin sutures were removed, 48 hours later the skin edges gaped and the wound remained open until on 11.1.44 it was necessary to refreshen the edges and resuture the wound. Advantage was taken to re-examine the cavity which was found to be lined by a thin translucent membrane. Satisfactory union occurred.

Patient has remained free from headache and the nose is clean. Lavage of the sinus produces a few shreds of pus. Six months after operation a 14 bougie passes readily into the sinus.

Another case has been operated on by the same method recently and the result promises to be equally satisfactory.

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contaminate the operation area. The operation is usually entered into by the patient in a spirit of co operation and not of apprehension.

*Disadvantages*—In local analgesia the operation area alone is anaesthetized. This compared with general anaesthesia is considered an advantage, but, the patient feels every little movement, his imagination is given full sway, he does not see what is going on but only hears what is happening in the theatre. The time of the operation is possibly lengthened. The surgeon has to be light fingered and at the same time keep up a continual flow of "vocal" anaesthesia. In other words distraction as a form of psychological therapy is an essential adjunct in operations under local analgesia.

The administration of a small amount of luminal beforehand usually overcomes any nervousness, or an injection of morphia and atrophine given half an hour before the operation does help the restlessness, but it must be remembered that morphia reduces laryngeal sensitivity and renders less effective the protective mechanism.

*Basal Narcosis*—The addition of a basal narcosis to the local anaesthesia is sometimes suggested, but full basal narcosis by the rectal route is not advisable. The circulatory and respiratory depression with consequent anoxia produced by avertin (bromethol) in the presence of cocaine and infected air passages prejudices considerably the patient's post-operative condition. If basal narcosis is necessary for some nervous individuals it is better administered by the more rapidly controlled intravenous route. Thus, a small dose of pentothal sodium (0.5 gramme) satisfies the patient's psychical need but, being rapidly eliminated, there is no unnecessary prolongation of deleterious depressent effects throughout the operation and after, such as frequently follows less controllable rectal narcosis. If a technical difficulty is anticipated with the patient's veins and a rectal administration is considered essential, paraldehyde is the best choice from the pharmacological point of view. Whichever route is chosen, however, to secure unconsciousness, the advisability of tracheal intubation is paramount, and this in fact amounts to general anaesthesia.

In nasal operations local analgesia and cocaineization have almost been synonymous. As a spray or as an application there are many substitutes to cocaine such as procaine or its proprietary preparations, percarine or anethaine which are said to be less toxic. In my own clinic I still use cocaine for packing a nose or as a spray. I have had unfortunate experiences with the substitutes. Cocaine is not now used for injection. Personally I have always used novocain, and have gone back to it after giving the substitutes a fair trial. Some people do exhibit a cocaine idiosyncrasy. Fortunately I have come across very few cases. Curiously enough I have had more trouble with cocaine substitutes though that is a coincidence and not a criticism of the cocaine substitutes. Frequently a patient shows the early signs of an idiosyncrasy to cocaine and one must be always on the look out for this. When these early signs appear the administration of baking soda by the mouth and/or coramine by injection usually act as an antidote and the operator can carry on with the operation. An early sign of cocaine idiosyncrasy that is seldom taught is the contraction inwards of the thumb towards the palm of the hand and the bending forwards of the hands on the wrists. I can only recall three cases in which the operation had to be postponed.

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The fact that the surgeon has to superintend the anæsthetic as well as operate may be included among the disadvantages of local anæsthesia. It is a disadvantage which could be easily overcome by the presence of a specialist anæsthetist who would be responsible for the management of the local anæsthetic.

Anæsthesia, be it "local" or "general", is often judged by its fatalities. In many cases an anæsthetic has been condemned just because of one of two mishaps—the mishap being due to carelessness in administration and not to the anæsthetic—the personal factor again.

If we are to judge local anæsthesia by its deaths then in my own wards we have never had a fatality in nasal operations under "local" in many thousands of cases. In dissection of tonsils under "local" we have records of five deaths (out of approximately 8,000 cases) in the past twenty-two years. An analysis of these five cases shows that two were the result of theatre accidents, where cocaine was used for injection instead of novocain. Nowadays all solutions of cocaine are coloured green in my wards while other local agents are coloured pink. One patient was given too large an initial dose of morphia, through carelessness was left unattended in a side room, fell forwards and asphyxiated herself. The fourth case was sprayed with a cocaine substitute. The spray used blew the substitute out of solution and the patient was given pure powder which was swallowed and proved fatal. The fifth case was a true idiosyncrasy. The patient shortly after injection showed signs of heart failure and collapsed just after the operation was completed.

*Regional Anæsthesia.*—Regional anæsthesia, in its true sense, is very little used except in operations on the antra. A nerve block of the sphenopalatine ganglion can be obtained by injection through the angle of the jaw or alongside the second upper molar or directly into the ganglion through the nose. Personally I have found that the ganglion can be quite well anæsthetized by pledgets of cotton wool soaked in 90 per cent. cocaine as suggested by Sluder, after local analgesia of the nasal mucosa by packing.

*Nasal Operations.*—It has been our practice in Edinburgh to use local anæsthesia for all nasal operations with possibly the exception of radical operations on the maxillary or frontal sinuses. In nasal operations we pack the nose for half an hour before operation, using  $\frac{3}{4}$ -inch ribbon gauze soaked in equal parts of 10 per cent. cocaine and of 1 in 1,000 adrenalin. This ensures a dry, insensitive field. In resections of the septum, after removal of the packing, the mucous membrane is injected with  $\frac{1}{2}$  per cent. novocain with about four drops of 1 in 1,000 adrenalin. By this injection the perichondrium can be separated off from the underlying cartilage, making the operation very much simpler and giving satisfactory analgesia. In operations on the ethmoids, the sphenopalatine ganglion (Meckel's) is further anæsthetized with probes, dressed with cotton wool and soaked in 90 per cent. cocaine, held in position for three minutes (a saturated solution of cocaine is approximately 67 per cent. but it comes out of solution very easily and is reckoned at 90 per cent.). Only a single drop is picked up on each probe and two probes are used to either side so there is very little extra cocaine apart from the packing. In some clinics the mucous membrane is rubbed with little pledgets of cotton wool soaked in adrenalin and cocaine (a crystal of cocaine dissolved

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in one drop of 1 in 1,000 adrenalin) We have tried this method—it saves a wait of half an hour before operating—but it does not give such a satisfactory dry field as the cocaine packs

*Dissection of Tonsils*—I am of the opinion that local anæsthesia is the anæsthetic of choice for dissection of tonsils in adults “Local” properly administered gives complete absence of pain, a clear field and no laryngeal difficulty In my own wards general anæsthesia for this operation is rarely used in adults Children are practically all operated on under ethyl chloride The pharynx is sprayed with  $3\frac{1}{2}$  of 10 per cent cocaine Using a curved needle the posterior anterior pillars of the tonsil are then infiltrated with  $\frac{1}{2}$  per cent novocain using 31 to each pillar I use a 311 syringe and one fill is sufficient to anæsthetize the posterior and interior pillars of one tonsil Using a straight needle 311 are then infiltrated into the bed of the tonsil through the anterior pillar After five minutes’ interval there is complete analgesia  $1/100$ th of atropine and a quarter of morphia reduces the patient’s nervousness in the theatre, though more often I dispense with the morphia and give luminal (depending on the body weight) one hour before operation There are some patients who prefer to be unconscious and in private the patient is given the choice between local and general anæsthesia The latter being intratracheal gas, oxygen and ether, or pentothal induction followed by cyclopropane

*Damage by Intubation*—May I digress somewhat from the discussion at this point and, as a laryngologist, sound a word of warning about general anæsthesia The laryngologist has already examined the nose and nasopharynx but the anæsthetist very often passes the intratracheal tube without previously inquiring into the condition of the mucous membrane The nasal mucous membrane is very readily damaged with resultant atrophy or adhesions and thereby a blocked airway Damage may be done to the larynx by tapping the tube on the cords already hyperæmic with the initial anæsthesia Recently I have seen three cases where the cords have been permanently damaged by the intratracheal tube

The possibility of secondary hæmorrhage has been advanced as an objection to local anæsthesia in this area If proper care is taken throughout the operation and all possible bleeding points ligatured there is no greater risk of bleeding with local anæsthesia than with a general anæsthetic Our experience is that there is a quicker healing of the tonsil beds after dissection under local anæsthesia as against general, though the guillotine operation performed under ethyl chloride gives the quickest healing of all

It is impossible to describe in detail all the operations on the nose and throat, for instance tracheotomy and laryngofissure which both call for local anæsthesia rather than general I must, however touch on operations below the larynx bronchoscopy and œsophagoscopy

*Bronchoscopy and Œsophagoscopy*—At a meeting of the section in 1938 suggestions were advanced by various anæsthetists for a prolonged anæsthesia in bronchoscopy and œsophagoscopy, forgetting that in these examinations the cough reflex must not be abolished and the examination on the bronchus should not exceed twenty minutes for fear of permanent injury to the mucosa which gets dry and cracked and easily infected if it is deprived of the moisture supplied to it from the nasal mucosa in the inspired air For œsophagoscopy I spray

## Societies' Proceedings

the throat with 20 minims of 10 per cent. cocaine, the patient having been given previously 1/100th of atropine. In bronchoscopy there is the additional anæsthesia with pledgets of gauze, dipped in 10 per cent. cocaine, held by means of angled forceps in the pyriform fossae for 30 seconds. This gives sufficient anæsthesia, a clear field and no interference with the cough reflex. Only when there is to be a consultation with the patient's doctor during the examination do I have the addition of a basal narcotic, again using avertin (bromethol) which does not interfere with the cough reflex. In children a similar method can be adopted using very little cocaine.

There is one important necessity in the use of this method and that is team work. The head must be held and not fitted into a head rest, and the shoulders held by a second assistant. The patient by this is given a feeling of confidence and security—the aim of all anæsthesia.

In our advocacy of local anæsthesia the counter-argument has been put forward, in the past, that we are a more hardy race in Scotland and that local anæsthesia is not for the Southerner. We may be more persuasive in our suggestion for "local", but there is without doubt a fear in the minds of a great many being put to sleep by "gas". As long as that exists local anæsthesia is their choice. It may be that with the induction by pentothal or a similar narcotic, thereby removing the fear of suffocation, more will demand a general anæsthetic, but I still believe that the safest anæsthesia is local and it is the only one in operations on the nose which fulfils the initial postulate of an open larynx, guarded against overflow and contamination.

H. W. LOFTUS DALE: The technique below described is one he has been employing on a considerable number of cases during the past two years for obtaining analgesia of the external and internal nose, paranasal sinuses and an area of adjacent skin surface adequate for any operation by paraneural block. The analgesia of the whole of this area was produced by blocking the maxillary nerve and with it the sphenopalatine ganglion and all its branches, the anterior ethmoidal and frontal nerves, through two points of entry only. Topical application of cocaine, whilst of value in producing local vasoconstriction, was not required for analgesia. Since the consequences of sepsis would be serious, all the approaches were made through the skin surface owing to the greater ease and certainty of sterilization. The use of a very fine needle for the initial wheals in conjunction with adequate premedication eliminated the objection on the grounds of pain.

For radical frontal sinus operations he had used anterior ethmoidal block and frontal block, unilateral or bilateral, as required. He had used this method well over fifty times for Mr. Norman Patterson's radical operation on nasal sinuses. For submucous resection of the nasal septum, in cases difficult for the application of topical methods, and in difficult traumatic cases, block of the second division of the fifth and sphenopalatine ganglion, bilateral, provided an analgesia which was much appreciated by the patient and surgeon. It would doubtless serve for intranasal removal of polypi, but he had not used it for that.

Many of the cases in his series required bilateral operations, the second operation being done at intervals varying from two weeks to even three months. All these had invariably been offered general anæsthesia, but it was a significant

fact that all had chosen regional. A careful follow-up had not revealed any case where pain had been complained of during operation. Complications had been few, trivial, and transitory, and the rapid convalescence of these cases had materially assisted the bed turnover.

Regional anaesthesia owed its increasing popularity in no small measure to a better understanding of the value of premedication. Indeed, it would be barbarous to inflict any fully conscious patient with even the initial discomforts associated with the procedures in question.

For premedication, pentobarbital sodium, "nembutal",  $1\frac{1}{2}$  to 3 gr. three hours before operation, and omnopon  $\frac{1}{2}$  gr. and scopolamine  $1/150$  gr. one to one and a half hours before operation was given to all save poor risk cases and to those over sixty years old, when the scopolamine was omitted. Before performing the blocks omnopon  $\frac{1}{2}$  to 1 gr. was given intravenously. Dilution to 5 or 6 c.c. facilitated the very slow injection rate necessary for the avoidance of overdose and unpleasant subjective sensations, and enabled the optimum degree of sedation to be judged with accuracy by noting the slowing response to questions and the development of myosis. Respiration should be watched carefully, and undue depression avoided. This technique enabled the anaesthetist to individualize the dose and to produce a state of calm co-operation with the preservation of protective reflexes and adequate respiratory exchange.

He cannot help thinking that the method deserves far more popularity than it at present enjoys.



## ABSTRACTS

### LARYNX

*Concentration Radiotherapy on Cancer of the Larynx.* MAX CUTLER, M.D. (Chicago). *J. Amer. med. Ass.*, April 1st, 1944, cxxiv, 14.

This is a report of 413 consecutive cases of cancer of the larynx observed from 1931 to 1943.

The lesions are classified with reference to the sight of their origin regardless of their subsequent extension; that is, cancer of the laryngeal vestibule, ventricular cavity, true vocal cord and subglottic region.

Biopsy was performed routinely in all cases. No effort was made to grade specimens.

Lesions that were radioresistant to the old type of irradiation are radio-sensitive to the new concentration methods. The basis of this new technique is the use of large daily doses over a comparatively short period and a total dose sufficient to produce an "epithelite" and usually also an "epidermite".

The usual plea for early diagnosis is made because only 88 out of the 413 cases were comparatively early.

The results of radiation therapy are superior to those of surgery and the patients have almost all normal voices.

Early lesions, limited to one cord, that have not reached the posterior commissure or crossed the anterior commissure have equally as good a chance of cure with adequate radiation as by the laryngofissure operation (80 per cent.).

When a cancer of the true cord is treated by adequate radiation therapy, while the cord is freely or partly movable the chances of recurrence after two years are extremely remote.

The article consists of 9 columns, has 8 tables and a bibliography.

ANGUS A. CAMPBELL.

### NOSE

*Sulfadiazine in the treatment of the Common Cold.* RUSSELL L. CECIL, M.D. (New York), Major NORMAN PLUMMER (Medical Corps, Army of the United States), and WILSON G. SMILLIE, M.D. (New York). (*J. Amer. med. Ass.*, January 1st, 1944, cxxiv, 1.)

The writers publish a preliminary report on the study of 72 colds in 66 different persons.

These persons were followed, clinically and bacteriologically; 48 received Sulfadiazine 3.0 gm. daily by mouth for four days, while 24 served as controls.

Following treatment, the nasopharyngeal flora showed a uniform decrease in the total number of organisms and a check in the growth of pathogens.

The clinical course of the treated colds showed no striking difference from that of the controls. But there did appear to be some amelioration of symptoms due to control of secondary infection.

The writers are opposed to the routine use of sulfonamides in the treatment of the common cold but would favour their use in a few selected cases in which the history of previous colds revealed severe secondary infection.

The article is illustrated, has several tables and a bibliography.

ANGUS A. CAMPBELL.

## MISCELLANEOUS

*The Chemotherapy of Intracranial Infections.* COBB PILCHER, M.D. and WILLIAM F. MEACHAM, M.D. (Nashville, Tenn.). (*J. Amer. Med. Ass.*, October 9th, 1943, cxxiii, 6.)

The writers use dogs in all these experiments. Meningitis was produced in them by injecting 0.1 c.c. of a saline suspension of a strain of hæmolytic staphylococcus aureus into the cisterna magna.

Treatment by penicillin intravenously was found to have little or no beneficial effect.

Intrathecal treatment of experimental staphylococcal meningitis with relatively small doses of penicillin reduced the mortality rate from 93 per cent. in controls to 54 per cent. in the treated animals.

Penicillin when injected intrathecally even in large doses produced no significant toxic effect.

The article has 6 charts and a bibliography.

ANGUS A. CAMPBELL.

*Penicillin in the treatment of Infections.* CHESTER S. KEEFER, M.D., FRANCIS G. BLAKE, M.D., E. KENNERLY MARSHALL, Jr., M.D., JOHN S. LOCKWOOD, M.D., and W. BARRY WOOD, Jr., M.D. (*J. Amer. med. Ass.*, August 28th, 1943, cxxii, 18.)

This is a statement, based on a report of 500 cases of various infections made by the Committee of the National Research Council (Medical Sciences Division), on chemotherapeutic and other agents.

Penicillin was found to be a potent anti-bacterial agent which can be given intravenously, intramuscularly or topically. It is ineffective when given by mouth.

It is excreted rapidly so that it must be injected continuously or at frequent intervals.

It has been found to be most effective in the treatment of staphylococcal, gonococcal, pneumococcal and hæmolytic streptococcal infections.

A patient requiring intravenous or intramuscular injection for serious staphylococcal infections requires a total of between 500,000 and 1,000,000 Oxford units, and the best results have been observed when treatment has

## Abstracts

continued from ten days to two weeks At least 10,000 units should be given every two to three hours, at the beginning of treatment, either by continuous intravenous injection or by interrupted intravenous or intramuscular injections. In the treatment of meningitis it is advisable to use penicillin injected directly into the subarachnoid space.

Toxic effects are extremely rare. Occasional chills, fever, flushing of the face and headache have been noted. Urticaria and thrombophlebitis at the site of injection have been noted. The article has 3 tables and a bibliography.

ANGUS A. CAMPBELL.

# The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

*February 1944*

## NEW OTOLOGICAL VIEWS

By DR. ADOLF SCHWARZBART (Cracow)

IN this paper it is proposed to present some new views on the following subjects :

- (1) The division of the middle-ear cavity and the Eustachian tube.
- (2) The origin of the pneumatic spaces of the middle ear and their covering epithelium.
- (3) The origin, morphology, extension and the function of the jelly-like embryonic tissue of the middle-ear spaces.
- (4) The pneumatization and the eburnation of the temporal bone.
- (5) The pathogenesis and some clinical aspects of middle-ear disease.

These observations are based on many years of my clinical experience combined with histological and histopathological studies of serial sections of one hundred temporal bones and Eustachian tubes. The work was carried out during the years 1934-1939 in the Jagellonian University, Cracow, Poland, and later on in the Medical School of the Hadassah Hospital in Jerusalem, Palestine.

### **1. The division of the middle-ear cavity and the Eustachian tube**

A new conception of the mucous membrane of the Eustachian tube and middle ear is presented.

The mucous membrane of the tube with its muco-serous glands and the lymphoid tissue is in sharp contrast with the lining of the rest of the middle-ear spaces. These spaces are devoid of a true mucous membrane. In view of their origin, their morphology and the lining they may be defined as a serous covering membrane, not secreting but rather transudative in nature.

Before discussing this in more detail it is necessary to refer briefly to some historical points.

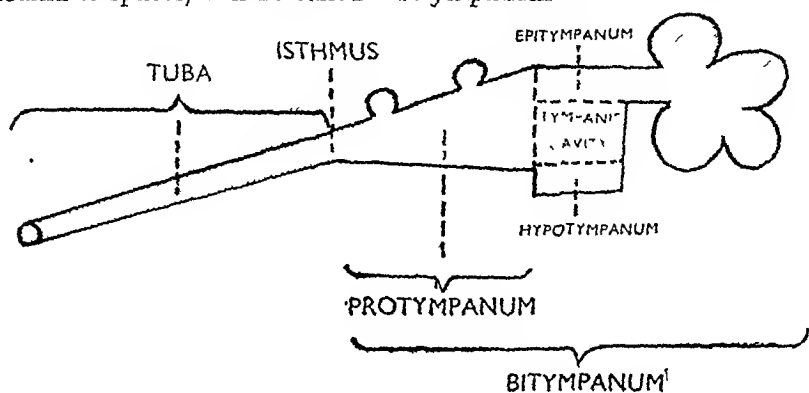
In the year 1563 Fallopius founded the conception of the tympanic cavity which is valid to-day, in that he compared its general shape to that

## Adolf Schwarzbart

of a military drum. Two years later Eustachio described the cartilaginous-membranous tube. In 1717, i.e. 150 years later Valsalva established the conception of the bony part of the tube. In 1862 Ruedinger described the definite division of the tube into the bony and cartilaginous-membranous parts. This holds good to-day.

Now, what exactly is the bony tube? From the historical point of view it is an anatomical section which was missed both by Fallopius and Eustachio in their descriptions. Fallopius did not fit it into his military drum form and Eustachio was interested only in the cartilaginous-membranous muscular canal connecting the middle ear with the pharynx. Actually the bony tube is a section lying between the tube of Eustachio and the tympanic cavity of Fallopius. Valsalva said about it: It is "a continuation of the bone in which is contained the tympanic cavity" (*Continuatio ossis, in quo tympani cavitas continetur*). In spite of this, correct observation it appeared to Valsalva, still more to Ruedinger, that this section was not part of the tympanic cavity, but rather of the tube. In their day, when clinical otology had not yet developed, these conclusions were of no special significance, and it was the authority of the writers that preserved the idea to this day. Valsalva's and Ruedinger's division is incorrect and cannot stand investigation from an embryological and anatomical or clinical standpoint.

Before proceeding to the proof of this statement, it is necessary to discuss the hereby proposed division. The complex conception of the cartilaginous + bony tube has to be split into its correct parts. The bony tube has to be separated from the "so-called tube", and from now on by tube will be meant a structure which corresponds in a general way to the original Eustachian tube, i.e. cartilaginous-membranous tube. The separate bony tube, an anterior evagination of the tympanic cavity, simply becomes incorporated into the tympanic cavity, and in analogy to epitympanum and hypotympanum will be known as "Protympanum". This extended tympanic cavity (tympanic cavity + protympanum + pneumatic spaces) will be called "bitympanum".



## New Otological Views

Since Rathke described the "buccal cavity" of mammalian embryos in the years 1825-1827, many divergent views have been expressed on the embryological origins of the tube and the pneumatic middle-ear complex. The most frequently presented view was, that the tube and the middle ear complex arose from the germinal tissue of the first branchial cleft. Reichert suggested that it was incorrect, and Frazer showed distinctly that the origin was of both types: the tube is formed from the germinal tissue of the first branchial cleft, but the integral parts of the middle ear, surrounded by the temporal bone, are formed independently from the germinal tissue of the second branchial cleft. From these integral parts of the middle ear there develops later the tympanic cavity with its pneumatic spaces and the bony tube, while the cartilaginous tube develops from the first branchial cleft. Thus, in accordance with our terminology, *the tube originates from the first branchial cleft and the bitympanum from the second cleft*.

From the point of view of *anatomy* the name "bony tube" is superfluous.

Among the methods used to demonstrate the shape and form of the middle-ear spaces is the taking of casts. Casts of the bony spaces and soft tissues show that the medial, lateral and superior walls of the human tympanic cavity pass without interruption of smoothness of line or surface to the corresponding walls of the bony tube (or protympanum). Only in the transition of the inferior wall of the hypotympanum to the inferior wall of the protympanum there is some interruption of line, and even here there is as a rule an obtuse angle.

The same picture is obtained from slides of longitudinal sections through the lumen of the tubo-tympanic space of man. These sections show that the bone reaches to the narrowest part of the tube, i.e. to the isthmus. Like the tympanic cavity, the bony tube is always a definite space, inalterable in size and shape while in contrast the cartilaginous tube in its state of inactivity is merely a potential space which opens but slightly, and only then as a result of active muscular contraction.

Also from the point of view of *comparative anatomy* the name "bony tube" is superfluous. When comparative anatomists speak of the tube they always mean a structure which corresponds in size and shape to the cartilaginous-membranous tube of human beings. The factors which bring about the narrowing of that part of the tympanic cavity known as the bony tube (protympanum) are (1) the tensor tympani muscle and (2) the bulge formed by the carotid canal. In those mammals in which the carotid artery follows a different course, there is no such structure as the bony tube. In spite of this narrowing the so called and generally recognized "*ostium tympanicum tubae osseae*" represents a construction absolutely artificial in nature, and except for the angle in the inferior wall is devoid of morphological or physiological foundation.

Further, in relation to the pneumatic system there is no difference between the tympanic cavity and the bony tube: the peritubal cells are essentially like the other pneumatic cells of the temporal bone, such as the periantral, peritympanic, mastoid cells, etc.

From the *histological* standpoint the border between the tube and the bitympanum is not so sharp. The typical mucous membrane of the tube with its ciliated epithelium may be followed beyond the border line of the tube into the protympanum, the tympanic cavity and even into the mastoid antrum. The lymphoid tissue, however, is always limited to the tube as a constant and characteristic constituent part of its submucosa. It does not encroach on the mucosa of the protympanum except in pronounced pathological conditions. The encroachment of the ciliated epithelium is explained as follows: Histological structures should not be regarded as absolutely static, for they are an expression of changing physiological processes which are going on in the organism. Supporting tissues such as bone and cartilage follow different biological rules from superficial tissues such as mucous membranes with their covering epithelium. The latter, in contrast to the former, are constantly affected by the function of defence against exogenous agents. In the foetus, where exogenous agents play as yet a small part, the ciliated epithelium is found limited to the tube. After birth, this relationship undergoes a gradual change. Thus the shift of the epithelium towards the protympanum sketched above should be regarded as an ever changing phenomenon, and in the adult as an expression of a continuously actual physiological defence process in the middle ear. The mucous membrane and its covering epithelium represent not a separating element, but one connecting and equalizing the two basically different regions, i.e. the tube and the bitympanum. This epithelial shift does not alter the fact that the bitympanum is a separate entity.

Consideration of the *physiology* of this region further supports the proposed division. The two essential functions of the bitympanum and the tube are the transmission of sound and the equalizing of air pressure. The equalization of air pressure is the function of the cartilaginous-membranous tube exclusively. It is carried out by the active muscular opening mechanism of the tube. The rigid walled bony tube has nothing to do with this function. On the other hand the protympanum, i.e. the bony tube participates in the sound transmission function of the bitympanum as a whole, i.e. also of the tympanic cavity and the pneumatic spaces of the middle ear.

## 2. The origin of the pneumatic spaces of the middle ear and their covering epithelium

According to a variety of opinions<sup>1</sup> the middle-ear region (i.e. the tube, the tympanic cavity and the pneumatic spaces) develops from the

## New Otological Views

"tubotympanic epithelial duct", a derivative of the first branchial cleft. Accordingly, the epithelial covering of this whole region is regarded as of an entodermal origin. In Keibel's<sup>2</sup> textbook of embryology this is expressed briefly "The epithelial covering of the middle ear originates from entoderm". From a part of the tubo tympanic duct there is formed a cleft, the "preformed tympanic cavity space". The tympanic cavity develops from it. Its epithelium rests on a thin basal membrane. In the interior there is found the foetal temporal bone with its periosteum, the bone is involved in a permanent process of metamorphosis. Between the epithelium and the bone there is found a thick layer of embryonic tissue, to which most variable names were attached. However, it is most frequently described as jelly-like tissue. In the fifth foetal month this jelly-like tissue begins to penetrate the bone, it erodes the bone and opens its marrow spaces. At the same time, however, it is subjected to a shrinking process. Thus there is formed a circular enlargement of the above mentioned preformed tympanic cavity space. This marks the onset of the pneumatization process which subsequently, following an essentially similar mechanism, continues after birth till the fourth or fifth year of life. Then the pneumatization of the middle ear is brought to completion in its main features. During all these phases the mucous membrane, especially the epithelium of the just formed pneumatic spaces, grows continuously into the newly formed ones.

Wendt (1873) has given us the histological definition of the jelly like tissue of the middle-ear spaces. The jelly-like tissue contains few star-like and spindle shaped cells provided with long processes. These processes are connected with each other in a net-like fashion. At the nodal points of the cell-processes we may find separate round cells. The described cellular framework is distributed in a seemingly amorphous, intercellular substance very rich in water. Till to day nobody has revised this definition. Thus it must be considered as valid in our time, too, although it is seventy years old.

As far as the distribution of the jelly like tissue is concerned Troeltsch finds it only and exclusively in the medial wall of the tympanic cavity of foetuses while Wendt also in the superior and inferior walls, though scanty.

And now some analysis of my own.

As is well known, the epithelium of the tube differs basically from that of the pneumatic spaces. The former is a double-layered stratified cylindrical ciliated epithelium with numerous goblet cells. The latter represents an endothelial like layer of flat epithelium. According to the above mentioned unitarian entodermal theory of the development of the middle ear the flat epithelium obviously is a derivative of the cylindrical epithelium. However, we cannot find in the literature even the slightest indication for an answer to the question when and through what intermediary cytological structures this transformation of the



cylindrical epithelium into a flat one is accomplished. The two histological structures are simply put together. There has been described only a demarcation line between them. However, individual workers, as for instance Koelliker, Kessel, Troeltsch, Brunner, Siebenmann, differ greatly in their opinion on this demarcation line. Brunner, for example, finds the cylindrical epithelium normally present in the whole tympanic cavity; according to Troeltsch, it generally ends at the ostium tympanicum tubae. A similar opinion is expressed by Wittmaack.

I have followed up this question by thorough study of numerous continuous serial sections of slides from foetal and post-foetal periods. I came to the conclusion that from now on the question of this demarcation line has to be considered in a quite different way. This line is not constant but is subject to marked individual fluctuations. Strictly speaking it does not exist at all, as I shall show later on by proving the opinion on the unitary entodermal origin of both epithelial types. I found that the post-foetal period cannot be of any help in answering this question as well as all the basic problems of the development of the middle ear, because the middle ear is already completed in all its main features at the time of birth. Moreover, also in the foetal period one has to look back to quite early times. While studying foetal periods early enough, I obtained results which in their principal points differ from those of such former authors as Hammar, Wittmaack, Siebenmann and others. My results agree fully with Frazer's embryological conclusions about the origin of the tube from the first gill cleft and of the middle ear from the second one:

In the fourth foetal month we find numerous small marrow spaces inside the just developing temporal bone. These spaces are placed at a certain distance from that embryonic tissue of tubal origin, which is known as tubo-tympanic duct. Among these small marrow spaces we find one which is remarkably larger than the other ones. Its red marrow tissue does not seem to differ at the beginning from the marrow of the small marrow spaces and actually they are communicating with each other. Gradually, however, there occurs a transformation in the structure of that larger marrow space. Its cytologic polymorphism, so characteristic for marrow tissue, disappears. It becomes poorer in cells. Finally, it assumes the poor-in-cell structure of the typical jelly-like tissue as described by Wendt. In this tissue there is formed further on a cleft-like space. To its walls endothelial-like cells, originating from the mesenchym of its marrow become apposed gradually. These mesenchymal cells come to be the covering epithelium of the cleft-space.

At the same time the above mentioned tubal canal, i.e. the so-called tubo-tympanic duct grows in the posterior and lateral direction, still separated from the described cleft space by a layer of germinal tissue. In consequence of growth processes of both the tubal canal and the cleft space

structures the two become approximated to each other. Finally, after the tissue separating them has disappeared, they unite to form a roomy continuing entity with a common lumen. This is the true origin of the tubo-tympanic space in which the 'above described cleft-space—a derivative of the marrow—is to be looked upon as the original tympanic cavity.

Teleologically speaking we should describe the process in such a way as to take into account a biological tendency which puts on a definite section of the marrow tissue inside the temporal bone a special function, namely that of sound transmission, while the tubal canal fulfils the function of equalization of air pressure, both functions being intimately associated with each other. Knowing the development we have to consider the described processes, i.e. :

- (a) the transformation of the rich-in-cells marrow into the poor-in-cells jelly-like tissue,
- (b) the formation of the cleft, and
- (c) the self-epithelization (*pneumatization*) of the cleft,

as an adaptation process to the acoustic functions. We may observe also elsewhere in human and animal organisms similar structural developments : for example during the formation of blood vessels from cleft-like structures of the mesenchyme.

It is clear that simultaneously with the fusion of the two mentioned structures also two different epithelia come into mutual contact : the cylindrical entodermal epithelium of the tubal duct and the endotheliform mesenchymal flat epithelium of the pre-tympanic cavity.

No question of any transformation of the cylindrical epithelium into the flat one or *vice versa* exists at all. That is the reason why no cytological structures of such transformation could have been described. From the first moment of their union the two kinds of epithelium are designed for continual contact, but they are *a priori* different and remain so. Their difference is not only a morphological but also a functional one.

The cylindrical epithelium of the tube resembles functionally and morphologically as well as in its origin the epithelium of the nasopharynx and that of the upper respiratory passages. Similarly as the latter it develops morphologically so as to form a typical mucous membrane, a loose submucosa and acinar sero-mucous glands. Also the adenoid tissue, stopping in the foetal tube at the ostium pharyngeum, grows gradually into the tubal mucous membrane. The tube forms a secretory organ as well as one of defence. On the other side the submucosa of the tube contain, especially laterally and inferiorly, rich loose tissue which is responsible for its ability to form folds. This is related to the motorial function of the tube (opening and closing).

Quite different from that of the tubal epithelium is the origin, the morphology and the function of the one-layered flat epithelium of the

bitympanum : in contrast to the highly developed tubal mucosa, the lining of the bitympanum is formed by a thin membrane. It forms only a delicate separating layer between the acoustic air-space and the periosteum of the temporal bone, respectively the jelly-like tissue. Spread smoothly over its basis it preserves the integrity of the pneumatic space and acts—together with ossicles, tympanic membrane, labyrinthine windows, ligaments and tympanic cavity muscles—as a sound-transmitting and sound-transforming medium.

On the other hand, it is relatively powerless when facing chemical, toxic and infectious factors. Never does it respond to stimuli by a secretion as it is devoid of glands. Depending on circumstances its reaction consists of transudation or exudation of a serous respectively inflammatory, at times also bloody or purulent fluid, possibly also with production of fibrin. It recalls both morphologically and functionally the features of a serous membrane. Thus, I might propose to consider the description of the lining of the bitympanum as a mucous membrane as unfounded and define it, in some analogy with the endocardium, as "*endotympanum*".

A few words must be said about the line of demarcation between the two kinds of epithelium: the cylindrical and flat one. As I have said already their delimitation is by no means constant according to the fluctuating physiological or pathological processes which take place continuously in the tubo-bitympanic spaces. Those processes are influenced by tubogenous or hæmatogenous factors. Of these factors the tubogenous ones are especially frequent. The growing significance of the latter during the last section of foetal life and still more so during post-foetal life brings it about that the cylindrical ciliated epithelium of the tube and its whole mucous membrane is continuously advancing against the delicate and somehow defenceless endotympanum. Just towards the end of foetal life it has proceeded as far as the border between the protympanum and tympanic cavity and even into the antrum. This may occur even when the physiological conditions be obviously undisturbed. The two epithelial types may grow through each other. In serial sections, from the ninth and tenth foetal months I found that in microscopically small parts the antral wall was covered alternately with one-layered flat epithelium and ciliated cylindrical tubal epithelium. No microscopical signs of any pathological processes in those cases were observed.

### 3. The origin, morphology, extension and function of the jelly-like tissue of the middle-ear spaces

The microscopic picture of the sparsely celled jelly-like tissue as described by Wendt is to be found only in a small number of my investigated cases. In the other cases I found all the possible transitional pictures starting with that of Wendt and ending with the typical pictures

of the richly cellular bone marrow. Considering the polymorphism of this tissue I propose to base its nomenclature not on a morphological but rather on a functional background and to call it "pneumatic tissue" instead of the term "jelly-like tissue."

The cause of the variability of the morphological picture of the pneumatic tissue is its lively reaction to any chemical, toxic and infectious stimuli whether they come out from the pharynx through the lumen of the tubo-tympanic space or from the blood stream. The acoustic middle-ear space demands absolute exclusion of any stimuli excepting those which are sound specific. To this state of ideal rest Wendt's picture of pneumatic tissue is adequate. We will call it the "classical" jelly-like tissue. Any disturbance will bring about migration of cells from the bone marrow into the pneumatic tissue. The result is an increase in its cell-numbers.

Gradually intensified cellular migration due to continuously acting stimuli may lead even to an inflammatory infiltration. I have myself found such a picture in the foetal middle ear and described them as "otitis media foetalis"<sup>3</sup>

#### 4. The pneumatization and eburnation of the temporal bone

I have described above the primary stages of pneumatization and the union of the pre-pneumatic space derived from the marrow tissue with the foetal tube. The next stages of pneumatization are accomplished in a similar way. Thus, at the end of the foetal period there is formed the mastoid antrum. Also in this case a pre-pneumatic space with its own mesenchymal epithelium is formed and later on it unites with the tympanic respectively epitympanic space. On the whole, as pneumatization continues, the subepithelial pneumatic tissue spreads more and more, still it never breaks its immediate connection with the deeper lying marrow tissue which is its mother-tissue. At the place where the pneumatization process has already come to an end, the pneumatic tissue becomes gradually thinned out and here and there it actually disappears. Later, in such places the endothelium of the bitympanum with its basement-membrane becomes directly apposed to the periosteum. In few places, however, the pneumatic tissue remains in the form of islands. Later I shall discuss in detail the significance of this fact.

It is very important to appreciate the fact that the scope of distribution of the pneumatic tissue corresponds closely to that of the bitympanum. It reaches on one side the far distant pneumatization region of the mastoid process and on the other side the narrow anterior end of the protympanum, i.e. the isthmus tubae. Here it ends sharply. The lateral wall of the tympanic cavity and of the protympanum, however, is not involved in the pneumatization process. That is due to the fact that the laterally situated os tympanicum of man is not subjected to any pneumatization.

Thus, the pneumatic tissue forms a further histological support for my proposed division of the middle-ear spaces into bitympanum and tube.

The tubal cells described in otosurgery as petrous-bone-cells are nothing else but a part of the whole pneumatic system of the bitympanum, shifted into an advanced position of the protympanum.

Besides the origin, function and the scope of distribution of the pneumatic tissue it is also important to know the age until which we may recognize this tissue in the sphere of the pneumatic system.

Nowadays Wittmaack's view is generally admitted that the pneumatic tissue disappears finally during the fifth year of life, i.e. at the end of the so-called third and last pneumatization phase of Wittmaack. In contrast to this I have found islet-like remnants of this tissue in elderly people. The slides in my possession showing this fact are from a 37 years' old individual. I feel justified in stating that in individuals with normal pneumatization the pneumatic tissue never disappears. This fact appears to be of fundamental significance. All through life the pneumatic tissue has as one of its main functions the challenge to the process of pneumatization.

Ossification and pneumatization are two antagonistic tendencies playing inside the temporal bone. Ossification is a quite general function of bone. It is being taken care of by osteoblasts. Pneumatization is a local specific tendency limited to the bitympanum and serving the pneumatized sound-transmitting apparatus. The state of normal pneumatization of the temporal bone is the result of equilibrium between functions of osteoblasts on one side and the pneumatic tissue on the other side. The relative strengthening of osteoblasts or a weakening or destruction of the pneumatic tissue leads to osteosclerosis (eburnation). This means that the pneumatic tissue does not represent only a factor of keeping the above mentioned equilibrium under physiological conditions, but also that it plays an important rôle in pathological processes. The bitympanic epithelium when destroyed by inflammation is renewed by this tissue. After spontaneous sequestration of the temporal bone as well as after oto-surgical bone-operations the remainder of the pneumatic tissue of this region represents a source for regeneration of the lost epithelium (epithelization) and also for renewed pneumatization-tendencies.

The epithelization of a cavity following a radical operation might develop according to this point of view not only from the ectoderm of the external auditory meatus, as is the general belief to date. It should be admitted that also the mesenchymal endothelium and even remnants originating from pneumatic tissue or marrow tissue participate to some extent in this epithelization process.

In the same way as inside the bitympanum the bony tissue with its osteoblasts and the pneumatic tissue, so also the whole of the tubotympanic tissue forms an equilibrium system of two structures which are essentially different in every respect, i.e. in their histogenesis, morphology

and function    *The tube* is the product of the first branchial cleft provided with entodermal epithelium    *The bitympanum* on the other side is a mesenchymal product which according to the studies of Frazer, is derived from the second branchial cleft and develops its tissue from the marrow of the temporal bone

*The tube* performs the twofold function of protecting the perfection and integrity of the acoustic work of the bitympanum, i.e. the equalization of air pressure and the defence, the first of them being performed by the cartilaginous muscular apparatus, the second one by its highly developed mucous membrane with its glands and lymphoid tissue and by its cilia    *The bitympanum* with its delicate endothelial covering is adapted to the acoustic functions only

## 5. The pathogenesis and some clinical aspects of middle-ear diseases

The artificial separation of the bony tube from the pneumatic middle-ear region and its incorporation in the conception of the tube could not help leading to some continuous confusion of ideas in the clinic of the tube and of the pneumatic middle-ear spaces    It made it *a priori* impossible to settle rational clinical entities    This feeling of unclearness grew during my many years of clinical otological practice and was the stimulus for these morphological studies

What I hope to obtain by means of the changes proposed here, is some improvement in clear-cut distinction between clinical disease-pictures which are essentially different in their symptomatology, pathogenesis and therapeutic indications    Here, too, as in the former section, I might start by proposing some innovations in the nomenclature    The conception of otitis media as a single entity has to be subdivided in accordance with our new division principle    The inflammatory diseases of the tube (as it is understood by me) will be described as "*Eustachitis*" and the diseases of the bitympanum as "*Bitympantitis*"

*Eustachitis* is a typical disease of the mucous membrane comparable with tracheitis, pharyngitis, rhinitis    It is closely related to them clinically and is frequently their consequence    *Eustachitis* has to be diagnosed, as far as possible, in conjunction with the above mentioned diseases by direct examination of the nasopharynx as well as of the tube, through the ostium pharyngeum and possibly has to be treated in the same way    This has been already raised, to some extent, by Gyergay and other authors    The condition of *eustachitis* shows besides the general symptoms also some special peculiarities which are conditioned by the cleft-like structure and the hidden position of the tube as well as by its function in respect to the bitympanum    These peculiarities are, shortly, (1) continuous gapping or occlusion of the tube, (2) propagation of catarrhal or suppurative infections from the nasopharynx and the

tube into the neighbourhood and especially into the bitympanum, into the cartilaginous tissue or into the muscles of the tube.

In the complex of *bitympanitis* we have to distinguish three principal conditions: (I) A disease of the endothelium of the bitympanum, i.e. of the endotympanum only. It may be called "*endotympanitis*". (II) A disease of the pneumatic tissue and of the marrow tissue which is intimately associated with it. A disease involving only the pneumatic tissue may be called "*pneumitis*", and if it is associated with a disease of the marrow then it may be called "*pneum-osteomyelitis*". (III) The third condition is a disease of the substance of the temporal bone. It may be called "*osteitis*".

(I) *Endotympanitis* to some extent conforms with the clinical conception of otitis media *non complicata* as we have understood it up till now. However, it shows some important differences. Firstly, it includes also the protympanum. Secondly, it excludes any other tubal disease. Thirdly, it is not a disease of the mucous membrane, as any conception of a mucous membrane in the bitympanum has been generally rejected. Endotympanitis, however, is a collective conception of greatly differing clinical pictures and it may be classified under many sub-divisions. It may be acute or chronic—serous, suppurative or plastic, manifest or insidious and even latent. It may attack different parts of the bitympanum or even all of them at the same time. The picture of an affection of the main tympanic cavity comprising the mesotympanum, the hypotympanum and the protympanum is different from that of the epitympanum (attic) and of the mastoid antrum. In the first case the tympanic membrane forms a favourable point of discharge. The picture is different when the attic and the antrum are attacked, while the hiatus epitympanicus is narrow and sometimes closed. Still other conditions are present when the endotympanum of the whole pneumatic system is affected. Yet, all these conditions have a good prognosis, whichever the clinical symptoms, provided that the otologist is enabled to be sure of the diagnosis "*endotympanitis*", this being essential for both prognosis and treatment. I will not enter here into details of this extremely interesting clinical question. It is proposed to present here only some preliminary remarks on that complex system. They are meant as a starting point, open for question and discussion. Before concluding this section I might devote a few words to the discussion of the histo-pathological process which forms the basis for the endotympanitis. According to the opinion prevailing in these days and especially to Wittmaack, a leading investigator of this fundamental question, one has to deal in the case of otitis media with a *metaplasia* of the one layered flat epithelium of the normal tympanic cavity and of the pneumatic spaces into a cylindrical, mostly ciliated epithelium.

However, this is not so. I have touched on this point earlier in this

## New Otological Views

paper What takes place here really, is a destruction (degeneration, tearing down) of the diseased, extremely delicate and labile endothelium of the bitympanum spaces, i e of the endotympanum I let us recall here that from birth on and actually earlier still, the cylindrical tubal epithelium is found, under physiological conditions, in a continuous advance against the bitympanum, and that the endotympanum grows through it in an islet-like and creek-like manner, so that in the child and still more so in an adult it may advance to distant parts of the bitympanum In a case of endotympanitis this cylindrical epithelium makes rapid progress and overgrows these regions of the bitympanum which became denuded of the endothelium by the inflammatory process We are dealing here with a defence-function of the tubal mucous membrane assigned for this purpose Thus, at the apex of the disease we find in the affected region a layer of cylindrical ciliated epithelium Also lymphoid tissue from the tube and also other cells derived from the deeper lying marrow-tissue of the temporal bone migrate into the bitympanum This is the picture of an inflammatory infiltration

Two alternatives are now to be distinguished

(a) If the damage is overcome regeneration of the endotympanum starting from the pneumatic tissue takes place At the same time the cylindrical epithelium withdraws into its old or almost old limits This is the histological picture of a *restitutio ad integrum* Such a process limited only to the endotympanum, i e endotympanitis, has not any influence on the state of pneumatization of the temporal bone, i e it does not form any basis of hindering it Such hindrance could result only from a definite damage done to the deeper layer, i e to the pneumatic tissue

(b) Another possibility in the clinical development of the endotympanitis is the irreversible destruction of the endotympanum In this case the advanced tubal cylindrical epithelium stays permanently These affected regions, devoid of their normal cover, may be looked at as devoid also of their specific acoustic nature Now, they are a damaged region provided with heterogeneous tissue the tubal mucous membrane Further developments may lead to transformation into plastic and later on into fibrous tissue This is the histopathological picture of the chronic adhesive process In such cases, also the deeper layer of the pneumatic tissue gradually suffer destruction This state of things results in the alteration of the pneumatic processes of the temporal bone, which is to be discussed presently

II *The condition of the inflammatory diseases of the pneumatic tissue and of the marrow tissue (pneum osteomyelitis)* corresponds in general to the clinical picture of reversible and not necessarily operative mastoiditis Also here the decursus may display the varieties mentioned in the first group in respect to the slow or quick course, the quality of the exudate



and the clinical symptoms. All the regions of the bitympanum may be attacked by it including the protympanum (tip of the petrous bone). It is this disease which leads to an alteration of pneumatic processes of the petrous bone, the so-called osteosclerosis or eburnation. This alteration takes place only in this case when the inflammatory disease does not result in a complete regression, i.e. when it leaves permanent damage to the pneumatic tissue. This occurs especially in latent, lingering cases. These are mostly hæmatogenous and not tubogenous cases. Thus, in my opinion, the very cause of the eburnation is in no way a disease of the mucous membrane as is admitted to-day, but an essential damage to that structure which is responsible for the equilibrium between the antagonistic tendencies of ossification and pneumatization, the former belonging to the osteoblasts, the latter to the pneumatic tissue and its mother tissue: the bone-marrow of the temporal bone.

III. *The disease of the proper substance of the temporal bone* corresponds in general to the clinical picture of mastoiditis with an absolute indication for an operative intervention. It develops either—mostly in acute cases—together with the pneum-osteomyelitis and leads soon to destruction of the bone, or it represents a subsequent stage following pneum-osteomyelitis and then it may develop insidiously. It leads necessarily to destruction of the bone.

In the conditions II and III we have to distinguish two types: the tubogenous and the hæmatogenous. While the tubogenous type is usually preceded by an endotympanitis and shows in the beginning the well-known picture of otitis media purulenta with an eventual perforation of the tympanic membrane, the hæmatogenous type does not always follow such a course. On the contrary, this form may progress almost without any of those middle-ear symptoms, and in spite of marked bony changes the osteoscopic findings may be extremely scarce. Only during the later stages of an advancing osteitis there comes sometimes a break through. This may occur into the sinus, the labyrinth and the meninges as well as into the bitympanum. These cases being latent in a strict otological sense demand early diagnosis by following other than purely otological methods.

The conditions of eustachitis and bitympanitis as discussed above do not appear always in their pure form, but frequently associated with each other. However, a careful analysis will find the proper way to work out eventually the clear differentiation of either of the two conditions from diagnostic and therapeutic view-points.

Above I have discussed some otological pictures in order to show by means of an important example that the view-points proposed by me may be useful for otological clinical analysis, and be a springboard for further investigations.

# New Otological Views

## Summary

(1) The established division of the middle ear cavity and Eustachian tube is untenable

(2) The bony tube being an anterior evagination of the tympanic cavity has to be separated from the so called tube, i.e. the cartilaginous + bony tube, and incorporated into the tympanic cavity. As integral part of the tympanic cavity it should be called "protympanum" in analogy with the epitympanum and hypotympanum

(3) The extended tympanic cavity containing the tympanic cavity + protympanum + pneumatic spaces should be called "bitympanum"

(4) The bitympanum spaces and their covering epithelia do not develop as usually supposed from the tubal duct with its entodermal epithelium. It develops independently from the marrow of the foetal temporal bone and its mesenchymal tissue. Consequently the union of the early tympanic cavity with the foetal tubal duct is a secondary process. This mesenchymal origin concerns also the whole of the further process of pneumatization of the temporal bone

(5) A new conception of the jelly-like tissue of the middle-ear spaces is presented and its rôle in various processes of the regeneration of the temporal bone and of pneumatization is pointed out

(6) The results of the former investigations lead to a new conception of the pathogenesis of otitis media and its complications and of the eburnation process of the temporal bone

(7) A new classification of otitis media with broader clinical aspects based upon the new classification is proposed

## REFERENCES

<sup>1</sup> WENDT TROELTSCH SIEBENMANN RUEDINGER DURSÝ HAMMAR BRYANT, BALFOUR POLITZER BEZOLD KEIBEL HUNT, CANAPÈLE YULE and many others

<sup>2</sup> KEIBEL MALL Developmental history of man

<sup>3</sup> SCHWARZBART A, Otitis media fetalis, *Msschr Ohrenheilkunde* 1937

## CLINICAL RECORD

### A CASE OF SARCOMA OF THE ETHMOID

By W. M. MOLLISON (London)

THE following case of ethmoidal growth seems of interest, not only because operations combined with radiation cured it, but that the type of growth changed in the course of a few years.

A girl, E.B., aged 12 was seen in 1926 ; before this the tonsils and adenoids had been removed ; discharge of muco-pus continued and epistaxis occurred daily ; the bridge of the nose was broadening and the girl had epiphora on the left side.

Examination of the nose showed a large pink mass on the left side and a diagnosis of ethmoidal growth was made. Operation was performed through a nose to ethmoidal incision ; the growth occupied the whole ethmoidal labyrinth and was invading the antrum ; the frontal sinus contained muco-pus. Section was examined by Professor Nicholson who reported *small round-celled sarcoma*. Three months later was well, no growth, only a large crust which was kept at bay by douching.

The patient remains free from growth for three years ; then a recurrence was removed and radium needles inserted.

Professor Nicholson now reported the growth was a *cellular basal-celled carcinoma*. Further recurrence occurred and in January 1930, a further external operation was performed ; there was much bleeding and the mass was removed from the ethmoid and from the upper part of the antrum. Section now reported as a *Neuro-blastoma with attempts at differentiation into glia : it is infiltrating widely and freely*.

In March 1930 a piece of tissue removed from the nose was reported on as follows : Oedematous cellular granulation tissue, no new growth.

Recovery satisfactory. Subsequently occasional attacks of frontal sinus retention.

No recurrence occurred. The patient has been seen in 1933, 1935 and 1944 and remains well ; except for mild attacks of retention in the frontal sinus. She married and has a child.

## CLINICAL NOTE

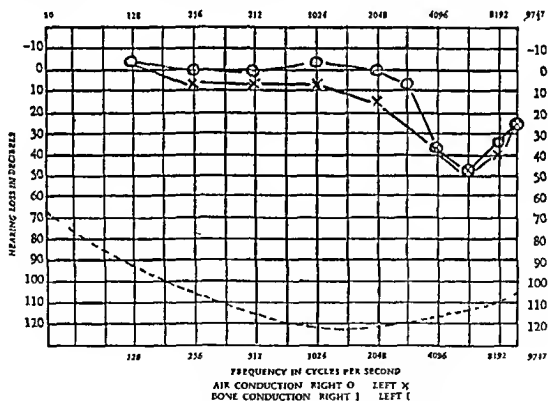
### THE AUDIOMETRIC DIP

By W STIRK ADAMS (Birmingham)

So much has been written both in England and America about the dip at 4,000 D.V. in an audiometric chart as attributable to noise trauma that I think the following case might interest readers of the journal

An active man aged 30 was referred to me this month because of a persistent post-nasal discharge of six years standing, without nasal obstruction, or headaches

He was worried because he thought his hearing was deteriorating and found some difficulty in hearing in cross conversation



Audiogram of Mr J G age 30 date 21st August 1944

No exposure to noise trauma no injury at all

On examination a widespread upper respiratory membrane infection was present, without dimming of his frontal sinuses or antra. In his ears a slight thickening of both drumheads was observed, and their mobility was less than the average

On testing he heard my whisper at 20 feet from either ear, while tuning forks revealed no deviation from the normal. The audiogram however which I

## Clinical Note

enclose shows a well marked dip at 6,500 D.V. (A.C.) which naturally raised the question of a possible cochlea injury by noise trauma.

He assured me, however, that he had never sustained a head injury or been exposed to explosion or loud noise. He had only twice been up in an aeroplane, and as a fruit grower he did not drive a tractor, nor was he exposed to the actual spray used on his fruit trees. In view of this I find it difficult to dissociate the dip from the effect of focal infection either from his chronic upper respiratory infection, or from his two devitalized teeth.

## SOCIETIES' PROCEEDINGS

### ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

Friday, November 5th, 1943

*President*—T B JOBSON, M D

#### Audibility of the Radio Voice

##### PRESIDENT'S ADDRESS

By T B JOBSON, M D

THE audibility of the Radio Voice must be considered from two points of view, that of the broadcasters and that of the audience

(1) Clear enunciation by the announcers goes a long way to help the deaf part of the audience, it also greatly adds to the comfort of those whose hearing capacity is good. One observes this in listening at the cinema. You hear every word spoken by actors such as Ralph Richardson, Herbert Marshall, or Aubrey Smith. You strain to catch the words of others who shall be nameless. Much of their speech is inaudible even to the non-deaf.

The only cure for this lack of audibility is in the teaching of elocution. Quite apart from broadcasting or acting, our everyday comfort would be greatly increased if people were taught to speak properly. I suggest that elocution should be a standard subject in our schools, for both boys and girls, and not an extra subject, as it is now.

(2) The audience consists of all types and conditions of men, the highly educated, the quick thinker, the poorly educated, the slow thinker, those with normal hearing, those with defective hearing, the young with quick reactions, the elderly with slight senile deafness and a time-lag in interpreting the sounds heard. Also, we must include a number of other nationals whose knowledge of English is not perfect.

The deaf audience varies, of course, from the slightly deaf to the totally deaf. It includes those deaf for high tones, as well as those whose hearing is deficient in the lower tones.

When the deaf person is listening to the Radio Voice, he has to listen harder. He often has to strain his listening power and develops fatigue. This applies very particularly to the middle aged and old people. They have a time-lag in interpreting the sounds. Their reactions to sound are delayed. So it follows that if such a person is listening to a very rapid speaker, he gets behind in his hearing, misses a word, and so may lose the gist of the sentences. He has to start again and do his best to catch up. He then gets tired of listening and gives it up as a bad job. When such a person listens to a speaker who

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speaks at an optimum rate, with adequate pauses, he has no difficulty whatever in hearing every word without fatigue.

In a broadcast on the B.B.C. announcers, Mr. John Snagge alluded to the listening "fathers", who did not hear as well as they used to. They represent a large and, I think, very important section of the audience.

The problem of the deaf has been taken up mainly by the National Institute for the Deaf. Their principal care, however, is of the deaf and dumb, and those suffering from extreme degrees of deafness, whereas our problem is to investigate subtotal deafness, to find out the numbers of the partially deaf who listen to the Radio Voice.

It is difficult to obtain any exact statistics of the partially deaf. In a survey made by Laura Spelman for the Rockefeller Foundation, it was found that three million children in American schools were suffering from some degree of deafness—a surprising number. In this country, evidence goes to show that the incidence is not so high. The Annual Report for year 1930 of the Chief Medical Officer of the Board of Education shows defective hearing in 6,859 out of 1,770,779 children examined. This is about 4 per thousand. Other investigators have found 6 to 8 per thousand.

The number of the deaf increases with age. The various causes of deafness, continue to operate and reach their maximum in old age. Mr. Arthur Wells investigated this subject in 1937 (*Brit. med. J.*, 1937 (ii), 18). After patient inquiry, he estimated that one in six persons in England and Wales was defective in one or both ears. This means that over seven millions of our people are somewhat deaf. This is a very considerable proportion of our Radio audience, and deserves the attention of the B.B.C.

## STATISTICAL REVIEW

From this short analysis of the Radio audience, it is clear that it includes a large number of people who are dependent for their Radio reception on the skill and care of those who are issuing the broadcasts. Not all of this number listen in, as it includes the very young, but it does include a very important group, namely, the elderly, who, in addition to their aural defect, develop a time-lag. They hear the sound, but their cerebration is slow. They take longer to analyse and register the sound. This compels them to listen more intently, and, after a time, this produces fatigue. The speed at which the broadcast is uttered, and the adequacy of the pauses between the sentences, is of extreme importance in producing comfortable reception and interpreting the sounds heard.

Senile deafness is composed of two factors: (1) Loss of acuity in hearing sound. (2) Delayed interpretation of the sound heard.

It is well known that hearing acuity diminishes with age. This diminution shows itself in the higher tones even at the age of 30. At ages over 50, the diminution for tones over 1,000 is marked. But even for tones in the speech range (128-512), acuity is lessened. At 60, the diminution is more marked (Fig. 1).

This subject has been investigated by Dr. Bunch at the Johns Hopkins University.

# Royal Society of Medicine

Fig. 1 shows very clearly the variation of hearing with age. It must be borne in mind that these tests were done on people who made no complaint of deafness. They do not include those whose deafness had become manifest.

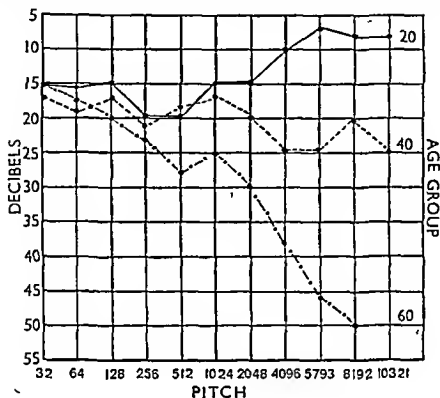


FIG. 1.

Graph showing loss of high tones with increasing age.

(Adapted from "Age Variations in Auditory Acuity", by C C Bunch, *Archives of Otolaryngology*, 1929, 14, 625)

We are concerned at the moment with the loss of hearing for the human voice—tones C.128 to C.512. The diagram (Fig. 2) (Negus, V. E., *Mechanism of the Larynx*, page 432, Fig. 151, Heinemann, 1929) explains this point very

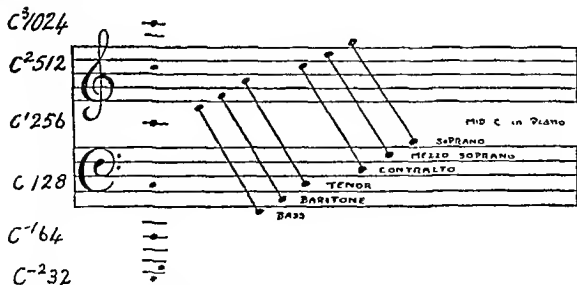


FIG. 2

Diagram showing range of the normal human singing voice (Adapted from diagram by V. E. Negus, in "Mechanism of the Larynx", p 432, Fig 151)



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clearly. It shows that the highest note in the average female voice is only midway between C.512 and C.1024, and the lowest bass note in the average male is midway between C.64 and C.128. The fundamental tones of the ordinary speaking voice lie between these extremes.

The second factor in senile deafness is delayed hearing, the slowing-up of the interpretation of the sounds heard, or delayed cerebration. The audiometer does not measure this factor. Even our consulting-room testing, by watch, whisper, and conversational voice, does not demonstrate this. A patient will often hear a whisper at 10 or 12 feet, and yet fail to understand a person who is talking rapidly, even in a louder voice. This combination of diminished hearing with delayed hearing exists in a large proportion of the Radio audience. This group must be added to that of the estimated one-sixth who show actual evidence of deafness.

The time-lag is a very important point. It increases gradually with age. Let us assume that it begins to manifest itself about the age of 50. The Registrar-General's figures for 1938 give the "over 50" (i.e. 50 to 85 years old and upwards) number of our population as 10,289,800. No doubt a large proportion of these are keen listeners to the B.B.C.

There are also a large number of foreigners here at present. They, too, have a lag unless they are very expert linguists.

All credit must be given to the B.B.C. for the trouble and care they take in making their broadcasts. The announcers are for the most part excellent. It is difficult to enforce a certain rate of speech and a certain space of time for pause, but I do think one should try to find an optimum rate, a rate that would not be tedious to the quick hearers, and yet acceptable to the deaf. The broadcaster is here in a dilemma. He has an audience of millions. He has to do his best to please everybody. Some of his deaf listeners, the early otosclerotics, and those with middle-ear deafness, hear the higher tones better. They hear the voices of children and females better than men. However, the number of people with this type of defect is much less than those who belong to the older group, who hear lower tones better.

My deaf patients say they can hear every word of Mr. Churchill's speeches, but hardly a word of some of our popular comedians.

The larger proportion of the deaf audience hear a man's voice more easily than that of a woman. Even the golden voice of the lady-announcer fails to charm. A man is certainly the best choice for a Radio speaker, but even he, if he wishes to reach the maximum number of his audience, must carefully arrange, not only his elocution, but also his rate of speech and his pauses. Of course one realizes that the slow, stately oratorical style is apt to be tedious to the majority of his audience, who have no hearing defect, but I do think that there is an optimum rate of speech, which, combined with adequate pauses, would give untold comfort to the deaf portion of his audience. It should be possible to ascertain this optimum rate of speech and thus bring comfort and enjoyment to millions.

Mr. JOHN SNAGGE: We of the B.B.C. are not unaware of our responsibilities in the matter of the spoken word. But it must be remembered that the microphone is a new invention and "broadcasting" was an unknown word in

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the days of my own grandfather Our age is 21<sup>st</sup> In ten days' time the B B C "comes of age" In those twenty one years we have had to find our way, and we have learned a lot, but we have not, and shall not, have learned all there is to know for many years to come Indeed, I have spent during those twenty one years only nineteen years in company with the microphone, and I can say with truth that the problems of to day are far greater than ever they have been, and I believe sometimes that the longer I spend in broadcasting the less I know

In the matter of medical science I am a layman The only training I have received in broadcasting comes from, probably the finest school of all, *experience*

What I may say about the Radio Voice must apply only to the work which is being done by the announcers, news readers, and those people who are selected and appointed to the B B C to be the official voice, or if you will, the "shop window" of the B B C We cannot any more than anyone else give people new voices We have not the time, at any rate just now, to be the Professor Higgins of Bernard Shaw's "Pygmalion" So far as the spoken word and English of the announcers is concerned, we are not there to instruct our listeners We are there to be understood by the greatest majority of listeners Criticism is often justified, and if constructive is often invaluable It is by this means that we have learned to find our way, and very largely why the B B C does to day hold a good deal of respect both in this country, and, in these days of war, throughout the world

The President's plea for the deaf is one of which we are not unconscious, and indeed I have myself learned much which I only hope may lead to a better service to them But they are not our only problem What of those who do not speak the English of the South, of those who speak and whose ears are attuned to the many dialects and hundreds of near dialect and accent speech in which we abound? Is our audience the individual sitting before his fire in his own home, or the one who is listening to a public loudspeaker with scores of others, or maybe the one who is trying to hear in a crowded and noisy canteen or the mess deck of a ship at sea?

And what of the quality of reception due either to bad reception areas or poor quality of receiving sets?

I would like, if I may, to say a word about the most obvious and best known of our activities so far as Home Listeners are concerned—that of the news bulletins and their reading To paraphrase a famous advertisement, they should be read 'Not too slow not too fast, but just right' What is "just right"? There are many factors which combine to make audibility and intelligibility The President spoke of enunciation This must be one of the most important factors, but it can be overdone, and when it is the all important rhythm of English may be lost It is, I think, a national failing that we are lazy speakers of our language We do not as a whole move our mouths properly when we speak Compare us with some foreigners such as the French or the Italians We have a habit of slurring our words and sentences, and I agree wholeheartedly with the President's suggestion that as a matter or course we should be taught to speak We should be taught all those things that go to make for clarity of speech—emphasis, pausing, speed, intonation I do not, however, suggest that a standard form of English should be spoken throughout the length and

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breadth of the country. Our true dialects should never be allowed to die; they are characteristics and traditions of which we may well be proud. But there are accents and intonations which are neither traditional nor pure, and which have crept into our speech, and which jar badly on the ear. But there must be, and I believe there is, a standard form of English which is understood by all, or nearly all, English-speaking people, and it is this form which we in the Corporation have tried to maintain.

The microphone and loud speaker are not kind. They tell the truth sometimes unpleasantly. There are many that I know, and I can speak personally, who when they first heard a recording of their own voice were surprised and often shocked.

We must always bear in mind that affectations or simple curiosities of speech which would not normally be noticed in physical conversation may cause continual irritations when heard through the loud speaker, and they are often emphasized. Once a voice irritates, the listener is distracted from the sense of the words or speech, and will often say that he cannot *hear* the speaker. In point of fact he is not listening.

There was a curious and interesting incident about the speed of reading which came to light a year or so ago. We were told by letter, telephone and verbally that the midnight news was always read 'much too fast'. Many people added that no doubt the news reader wished to go to bed, but that night was the only chance he or she had to listen, as they worked all day and late. The accusations became so general that I investigated the facts.

It was found in fact that there was no alteration at all in the speed of reading. What was, I think, the answer was that the reaction of the listener at that time of night, and after long hours of work, was slower. The fault did not lie with us, but the cure did. The midnight news is therefore so far as possible read just that fraction slower.

The broadcaster has to rely solely upon his voice—he cannot give meaning or clarity by gesture or expression as we do in our conversations. Therefore clarity of enunciation is of the first importance.

I have learned much from what the President has said regarding speed in relation to those whose misfortune it is to be deaf. I think there may well be a general optimum, but there is also an individual optimum. There can no more be a general optimum speech for all and any speaker than there is a general standard of language. The individual characteristics count greatly in accordance with the other factors which go to make for clarity. The speed in words per minute of those who read the news varies between 163 and 176 words per minute, but one is said by our listeners to be more audible than another. And not by any means the same reader; and certainly the most audible is not the slowest.

The secret of speed does not lie in words per minute, but in proper and adequate pauses and in realizing and transmitting the sense values of the English language. Here, too, rhythm plays an all-important part; a pause however brief, wrongly placed, can cause the listener uncertainty as to the meaning, and in adjusting himself thereby does not listen to the next few words.

The B.B.C. during its few years of existence has not only adopted a standard form of English with so far as possible a standard pronunciation, but has also

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developed and established a standard form of reading the news bulletins. We heard much at one time about the "tendentious inflection", implying that the reader was conveying his own interpretation of the news and failing to be impersonal, others complaining that he was so impersonal that he showed his disinterest in the news. He must be impersonal, not only in the political matters, but in all facts, news, and information, it is his job to convey. It is for the listener to give the interpretations.

During 1940 when the reading of news was not a particularly pleasant or enviable occupation (we broadcast day after day a series of setbacks and of defeats) it was no uncommon thing to receive letters from our listeners saying on the one hand "I know the news is bad, why should the reader make it worse?" and on the other hand "The news is bad, but don't let the reader put on forced cheerfulness". And both listeners would be referring to the same bulletin and both asking "Why can't we have someone to read the news whom we can hear?" What they really meant was "to whom we will listen". You may be quite sure that when it is good news these same people will, and do, listen regardless of the reader.

Twice recently an experiment was tried by introducing to the regular team a reader who brought with him inflections and traces of dialects not heard amongst news readers till then. One was from the North Country, another from Scotland. Both these men were good readers so far as tone, speed, emphasis, and phrasing were concerned. The experiment failed—failed that is from the general point of view. They had of course a full measure of appreciation from listeners in their own areas or county. It failed for two reasons. Firstly because they were different from the others and from each other and therefore distracting. The short "a" was heard in words like 'aircraft', 'castle', and many were listening not to *what* he was saying but *how* he said it. In another case the listeners complained that they never knew whether he was talking about Burma or a bomber, and once again we were told that *he couldn't be heard*.

The second reason is I think interesting. Both these men said the same thing. It was, they said, difficult for them to read the news as it was written and give full value to their form of speech. The idiom of the North and Scotland is quite different. The writing was Southern English and the voice Northern.

Many times we have been asked whether women will ever read the news and if not, why not. The answer is that it is not the intention of the B B C to appoint women news readers at present. This is in no way a reflection on their ability to read aloud but because there are many people whose feelings would be ruffled in hearing news descriptions of war and particularly of battles read by women, and there is also the additional reason that, as the President so rightly said, a man's voice is by many more easily heard than a woman's.

I hope I have been able to give some idea of the complexities which surround the life of the official broadcaster. It is a form of public speaking which is not comparable with any other. Recently we made an investigation into the speeds of speech of a number of people who broadcast. Figures taken, all over a period of three minutes showed that the speeds of the professional broadcasters headed a list in a group. The fastest of the news readers showed the figure 528, the slowest 488.

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The difference is almost entirely made up not by speed of words, but length of pauses. The average pausing between sentences in the first case being just under two seconds, and between items three seconds, and in the second case two seconds between sentences and over four between items. The clarity in both cases was excellent. The other readers all maintained the same average speed with the same average pausing. Commander Kimmins who has broadcast so admirably on Naval affairs showed a speed in this category—510 words over three minutes, but his average pausing showed only  $1\frac{1}{2}$  seconds average.

The second group are taken from the ranks of public speakers. The Prime Minister, speaking over the microphone following the fall of France, averaged 400 words in three minutes with average two second pauses at end of sentences and  $2\frac{1}{2}$  at the end of paragraphs, and 1 to  $1\frac{4}{5}$ th in mid-sentence.

The Deputy Prime Minister's speed was also 400 words in three minutes and his pausing at the end of sentences slightly less than two seconds, but mid-sentence pausing the same.

The Archbishop of Canterbury, in broadcast address, was considerably slower, 325 in three minutes, but the pausing was considerably different. In mid-sentence or mid-phrase pauses were sometimes as great, if not greater, than at the end of a sentence or paragraph. This is a speech device frequently heard in the Church. Possibly it is the result of the spoken as opposed to the written word.

One further instance is, I think, interesting. In a studio broadcast the Foreign Secretary spoke 385 words in three minutes with average pausing. A broadcast speech from the Royal Albert Hall before a large audience, showed a rate of 100 words. Here surely is the reason why the public speaker when before the microphone shows a considerably lower speed. (The figure of 100 is, by the way, the figure excluding applause.) The public speaker can gauge his speed by his visual audience. He can, in a large hall, theatre, or church hear his own voice and hear perhaps the echo of it. The broadcaster cannot.

If the broadcaster were to speak as though he were before a large audience, as though, in fact, he were on a platform, the listeners would be the first to condemn.

No one wishes to have speeches made to him in his own home. He wishes to hear clearly, not loudly, intimately not pompously, or too formally, what the news or information is. Here lies the success of many broadcasters—C. H. Middleton, Christopher Stone, the late Professor John Hilton. It's not so much what they said as the way they said it. They used the language and phraseology of the ordinary man. Their speed, their pausing, their emphasizing, their tone, was normal in everyday speech and they could be heard.

The average receiving set does not give a true and faultless reproduction of the sound vowels and consonants as they leave the mouth. Much of it, when heard at the loudspeaker, must be guesswork. If the English is strange, the strain on the listener is greater and the greater the strain, the sooner the fatigue, until the listener gives up and complains he cannot hear.

We in the B.B.C. must remember that the listener should not have to strain to listen. That is why our Talks Department and our Presentation Department

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spend much time in editing and watching the scripts and announcements which are broadcast, so that what is said should be said in the simplest way and thereby understood and heard without strain or fatigue

The President referred to some of the comedians who broadcast. Not all are transgressors in the matter of speed. How often do we hear a question asked by one and the question repeated by his companion and sometimes twice repeated before the answer and the joke is told! But there are others, I agree, who are fast and much of the success of Tommy Handley is his speed and the unexpectedness of his remarks. Take these away from him and his popularity would quickly die. I fear there may be a number who cannot listen through faulty hearing, but I do know cases of elderly people who do and can hear him because I think they enforce concentration.

But they are the artistes who come on occasions to the B.B.C. The regular broadcasters, and particularly the announcers, have many factors to bear in mind in front of the microphone, and they have, by experience, developed and practised a fairly consistent rate of speech. The optimum must, I think, be largely individual, the natural characteristics of the individual should be retained.

The great disadvantage of broadcasting is that it makes its appeal to one sense only. It is of the utmost importance that broadcasters should keep in mind the value of the beauty of speech. They must, in addition to regularizing their speech, modulate the voice as to pitch, emphasize correctly and be skilled in the subtle use of pauses so as to introduce the exact shade of colour required to keep up the interest and prevent any suggestion of boredom. And they must never forget that "father does not hear quite as well as he used to."

Mr V E NEGUS said that the first interesting point about the range of voice was that the human capacity for hearing must be attuned to the range of the human voice. Fish, for example, could perceive sounds very much lower than those which were audible to the human ear, because they lived in a different medium. Some animals like shrews and bats no doubt had a range of hearing set to a higher pitch. In an audiogram it was obvious that the range of hearing did exceed the limits of speech. The diagram which the President showed indicated only the fundamental sounds. In the construction of the receiving set and in the hearing aids it was not the fundamental which counted for very much. Hartridge, in Stirling's *Physiology*, showed that one could cut out all the lower pitches, including the fundamental, without diminishing the audibility for speech, and the important range appeared to be between 500 vibrations and 4,000. The overtones which made up the pattern of speech, whereby people guessed the meaning of the words, could be very high, and on a pitch of 2,000, if the overtones extended for three octaves above, the highest overtones were extremely high. The overtones varied in their intensity, the low ones being amplified more than the high, and it was the pattern of overtones which made the speech intelligible.

The male voice, speaking on a lower pitch, had overtones of a lower pitch than the female and therefore was likely to be more easily audible to the person who had lost the high tone.

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taught the proper way to give instructions and orders, and gramophone records were made of their voices and played back to them to make them aware of their faults.

Mr. H. V. FORSTER said that in an effort to arouse the interest of the student to understand the mechanism of voice and speech, he had been grateful to be able to refer to Mr. Negus' well known comparative researches in the animal world. The voice of the ox was mellow because of the massive structure of the vocal cord. The voice of the parrot owed its quality to a well developed syrinx, but its remarkable powers of speech were due to the large and mobile tongue. The rigid beak would be a poor substitute however for the flexible lips and cheeks of man.

He would ask Mr. John Snagge to account for the popularity of the crooner. It had occurred to him that his success depended on clear diction, that of the legitimate singer on vocal instrumental effect rather than the listener's appreciation of the sung word.

Good diction relied on the clear enunciation of consonants. To confuse the numbers "five" and "nine" was common in telephone calls.

It was obvious that the "signal" language of the Armed Forces was designed to avoid such errors which might have serious consequences.

Mr. JOHN SNAGGE (in reply) said that on the question of scientific investigation with the cathode ray, this had been a serious consideration with the B.B.C. and was taken up by them before the war. In wartime, however, they had not been able to get any further with it. Before the war they had had the help of the late Professor Lloyd James, an expert in phonetics, who was actually investigating with the cathode ray at the time the war broke out. The B.B.C. would eventually do something of that nature.

On the question of gramophone records of speech, this could be a very dangerous thing. The gramophone record of a man's own speech might shock him so much that he would be afraid to speak thereafter. He recalled an instance in the B.B.C. when a record was taken of the talk of a certain speaker and after he had finished a loudspeaker came on, repeating his speech from the record. This man listened for a minute or two, and then he said: "Who is that pompous ass who is reading my speech?" In fact, he could not tell whether anybody was going to be a good or a bad microphone personality by merely listening to them. Their speech had first to be recorded.

On the matter of acoustics the B.B.C. had done a great deal in this direction. The first step was carried out when they moved into Broadcasting House where the studios were specially designed, as they had not been at Savoy Hill, and various experiments were carried out in the matter of the lining of the walls. He did not himself think that to the listener it made a great deal of difference. Extremes, of course, were bad, but generally speaking the question of acoustics in the studio had little effect on the reception at the receiving end. It had to be remembered that there were many bad sets in existence in the country.

Some speakers at the microphone preferred to hear themselves when they spoke, and others did not. Some even blocked their ears when they spoke, while others had headphones in order that they might be sure of getting their voice coming back to them.

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He had been asked a question about crooners. The whole question of crooning was very much in dispute. But crooning, after all, was only possible by the use of the microphone. It was a microphone trick. If the microphone were taken away from the crooner the audience would not hear a word, perhaps not a sound, and, of course, clarity of speech when one was talking or singing very quietly into a microphone was easily possible. It gave the greater opportunity of obtaining the values of the vowels and consonants. If the crooner suddenly opened his lungs and sung at the top of his voice, again, probably, the audience would not be able to hear clearly a single word.



## REVIEW OF BOOKS

*Diseases of the Nose, Throat and Ear.* BALLENGER. Published by Henry Kimpton. Price 6os.

The eighth edition of this well-known textbook contains several new features. One of the most interesting is the description of King's operation for bilateral abductor paralysis in which by an external approach the crico-arytenoid joint is disarticulated and the arytenoid cartilage displaced outwards and held in this position by passing a suture submucously round the arytenoid cartilage and fastening it to the lateral border of the thyroid cartilage. This separates the vocal cords and produces an adequate airway.

Lampert's endaural approach to the mastoid is described and illustrated. It is questionable whether it is as adequate or simple as the post-auricular route for most cases of acute mastoiditis especially if a lateral sinus thrombosis is suspected but it certainly does give an excellent view of the attic region when the conservative operation is in question.

The endaural approach is also used for the fenestration operation for otosclerosis which is fully described but no end results are mentioned.

The section on the Surgery of the Frontal Sinus seems rather unsatisfactory and suffers from the retention of old fashioned procedures alongside more modern methods with little indication of their relative values. Surely intra-nasal rasping operations are a thing of the past and cannot be compared with the excellence of Mosher's procedure.

It is also curious still to find a long illustrated description of the Killian operation which must surely be seldom used nowadays. Your reviewer drew attention to its unsatisfactory features more than twenty years ago after seeing many disappointing results in Killian's clinic and elsewhere. The majority of nasal surgeons now employ some form of drainage operation such as that here described under the name of Lynch. The section on Bronchoscopy by Gabriel Tucker is concise and admirable. It may be commended to the notice of the increasing number of thoracic surgeons who perform bronchoscopy.

The book concludes with the usually clear description of œsophagoscopy that is always associated with the name of Chevalier Jackson.

WALTER HOWARTH.

*Diseases of the Nose, Throat and Ear.* J. SIMSON HALL. E. & S. Livingstone Ltd.

The third edition of this excellent little book does not contain much new matter but it has been brought thoroughly up to date and somewhat rearranged. Four coloured plates increase the value of the book. Three of these are admirable but surely the fourth one depicts an infection much milder than those usually encountered in hospital practice. Otherwise the book maintains its high standard and its clearness and conciseness should prove of great value to the student and practitioner for whom it is especially designed.

WALTER HOWARTH.

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*March 1944*

## THE TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA BY THE LOCAL APPLICATION OF PENICILLIN AND OTHER DRUGS

By E G COLLINS, Major, R A M C, and K E A HUGHES, Major, R A M C

CHRONIC Suppurative Otitis Media is a serious medical problem in the British Army and results in much wastage of man-power. Under the sponsorship of Major General L T Poole (Director of Pathology to the Army) and Brigadier Myles L Formby (Consultant Otorhinolaryngologist), an investigation was made by us at a Military Hospital to determine whether the local application of penicillin would prove a satisfactory remedy for this very prevalent disease. Twenty three patients were admitted as in patients for this investigation, but only nine of these were treated with penicillin for reasons which will be detailed later. The investigation lasted for three and a half months. It will be appreciated that the smallness of the number of patients treated does not permit very dogmatic statements to be made, and that any conclusions we may reach must be regarded more as expressions of opinion than as a final judgment on the value of any particular line of treatment. At the same time, as this investigation involved the examination of 540 cultures and over 300 smears from the aural discharge, it afforded a considerable insight into the bacteriology of chronic suppurative otitis media, and it is from this wider standpoint that we wish to approach the subject in this paper rather than to limit our discussion to the value of penicillin treatment in this disease.

Two methods of control were open to the investigators. The first method consisted of treating a group of patients who had penicillin-sensitive organisms in the aural discharge and contrasting the effects of the local applications of penicillin against a similar group treated by the same method but with different medicaments. To be of value this would involve the investigation of at least a hundred patients in each group in

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order to discount the variations in pathology that occur. Such an investigation would last for two to three years and would demand large supplies of penicillin. Consequently, for practical reasons it was necessary to adopt what Sir Almroth Wright has termed the "se ipsis" method of control, i.e. different methods of treatment are tried out on the same patients and the results observed both clinically and bacteriologically. It can be argued with considerable truth that the prolonged attention which these alternative methods of treatment involved, will lead to some degree of clinical improvement but, as far as could be judged, these other methods had comparatively little effect on penicillin-sensitive organisms. Where penicillin was tried in combination with local or general sulphonamides, the effect of penicillin alone had first been determined.

### The Bacteriology of Chronic Suppurative Otitis Media

Whereas in acute otitis media penicillin-sensitive organisms, such as the staphylococcus and streptococcus, are of frequent occurrence, it was found that in the *initial* cultures of chronic suppurative otitis media such organisms were seldom present. In the twenty-six ears which were investigated (three patients had bilateral disease) staphylococci were found in the initial cultures on only three occasions, and from only one of these was a pure staphylococcal growth obtained. The remaining initial cultures grew "coliform" bacilli ten times, proteus thirteen times and diphtheroids six times. A mixed growth of organisms was a fairly common occurrence. This figure for the incidence of staphylococci in the cultures differs considerably from some others which have been published by Valentine, Fowler and Wirth. They found staphylococci in the aural discharge in a percentage which varied between 30 and 60 per cent. It is suggested that this discrepancy may arise from the method of taking the cultures. Our cultures and smears were taken by means of a platinum loop introduced through the perforation into the middle ear and then inoculated directly on to the culture media. Some of the other authors state that their cultures were taken by means of a wool swab introduced as near the site of the perforation as possible. This latter method makes meatal contamination unavoidable and, in an examination of the bacterial flora of eighteen normal meatuses, one of us found staphylococci present sixteen times. A further factor which may have affected the results is the chronicity of the aural discharge. Most of our cases dated from childhood or the discharge had been present for more than ten years. Little information is available on this subject in the figures given by other authors.

So far we have only discussed the initial cultures, and the most interesting feature of this investigation was the changes in the bacterial flora that occurred as the result of treatment. Although the staphylococcus was found only on three occasions in the initial cultures,

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yet, as the result of treatment by methods other than penicillin, this organism made its appearance in five other ears. When the staphylococcus was found, a coagulase test was invariably carried out to determine if it was a pathogenic strain and, although coagulase negative strains were sometimes present, a coagulase positive or pathogenic strain was found in each of these five patients during some period of their treatment. A similar metamorphosis occurred in the bacterial flora of those patients who were treated by local applications of penicillin but, here, it was mainly some of the gram negative bacilli which made their first appearance. After or during a course of penicillin, "coliform" bacilli were found for the first time on six occasions, *B. proteus* on five occasions, diphtheroids three times, *Streptococcus hæmolyticus* twice and *Monilia* (*Candida albicans*) six times. We were suspicious that this latter fungus might be a contaminant of the penicillin, but further tests showed that this was not the case. We consider there can only be one explanation of this unusual feature. We must regard the bacteriology of the chronic ear as an outstanding example of antibiosis where one or more species of organism suppresses the others and becomes dominant. The exact mechanism of antagonism that exists is as yet undetermined. It may be due to the presence of definite metabolic products, non-toxic to the organism itself but toxic to other species, or it may be due to one organism depriving the others of their food. If we disturb the bacterial balance by treatment which destroys or retards the growth of the dominant species then it would appear that we shall allow other organisms which are latent to come forward and assume a dominant rôle. A further point of interest is that in three patients in whom a mastoid operation was performed, no gram-positive organisms were cultured from the middle ear discharge, but from bone chips around the mastoid antrum at operation a staphylococcus was grown in two patients and a streptococcus in one. Though this may prove to be an uncommon finding it suggests that in chronic suppurative otitis media cultures from the middle ear discharge are not necessarily a true index of the organisms which are causing the mastoid disease.

## Penicillin Sensitivity

Of the organisms which have been mentioned in the account of the bacteriology of chronic suppurative otitis media, only the staphylococci (coagulase positive and coagulase negative strains) and the streptococcus are normally sensitive to penicillin and even these may at times prove to be completely or partially insensitive. Instances of such relative insensitivity were found on five occasions during the treatment of a variety of aural conditions with penicillin. The *B. proteus* and "coliform" bacilli are uniformly insensitive whilst we found that the diphtheroids showed considerable strain variability in this respect. The

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penicillin used was the calcium salt, the strength of which was 800-1000 Oxford units per cubic centimetre. It will be clear that the results of our bacteriological examination divided the patients into the two groups according to the sensitivity of the organisms to penicillin.

### (A) Penicillin-Sensitive Group

#### METHODS OF LOCAL APPLICATION OF PENICILLIN

Two methods of application were used. The first consisted in forcing a solution through the perforation into the middle ear by means of a Politzer bag and the remedy was kept in contact with the lesion by a gauze wick passing down to the perforation and moistened at eight hourly intervals with penicillin solution. This procedure followed a preparatory cleansing of the middle ear by intratympanic syringing. On the average treatment lasted 10 to 14 days. As it appeared to us mechanically impossible for the penicillin to come into adequate contact with the disease when there was mastoid involvement, in two patients, where operation seemed indicated, we adopted the second method using the technique which has been described by Macbeth. In both patients an extensive Schwartze operation only was performed. A modified radical or radical operation would have been the normal procedure in one of the patients as there was considerable disorganization present in the middle ear. The skin was sewn up completely and no plastic flap was made. Two fine rubber tubes were inserted through the mastoid wound and stitched into place. The first led directly to the aditus and middle ear and the second drained the mastoid cavity at its lower end. Penicillin solution was instilled through the tubes and a penicillin-sulphacetamide solution was instilled on to a gauze wick in the external auditory meatus. Applications were carried out three times a day and the patient received 4,600 Oxford units of penicillin in the twenty-four hours. Treatment continued for 8 to 10 days.

Daily cultures were taken in both methods and frequent sensitivity and coagulase tests as well as penicillin assays were made. Seven patients were treated by the Politzer bag and wick method; one by operation with perfusion; and one by both methods.

*Bacteriological Results.*—Though only nine patients were treated by penicillin, fifteen courses in all were given, as in five patients two courses were tried and one patient had treatment to both ears. In thirteen of these courses the penicillin-sensitive organism disappeared between the first and fifth day of treatment. In two courses, staphylococci were not present at the beginning of treatment but had been found previously. In one of these, staphylococci persisted in smears from the third to the twelfth day in spite of treatment but were not grown on culture—perhaps owing to their overgrowth by a proteus bacillus. This disappearance of

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the penicillin sensitive organisms was followed by a recurrence of staphylococci in all the patients between one and ten days after the penicillin had been stopped. Sometimes this recurrence was only temporary but in three patients it persisted throughout the patients' stay in hospital.

## THE CORRELATION BETWEEN THE BACTERIOLOGICAL AND CLINICAL RESULTS

This clinical record illustrates the contrast methods of treatment used and is a good example of the changes in the bacteriological flora that occurred as the result of treatment. A number of the other cases showed similar bacteriological changes, but these have not been detailed in the abridged records given owing to limitation of space.

The points of interest in the record (Fig. 1) are as follows:

(1) The double perforation and chronic suppurative otitis media was probably of longer duration than stated as there had been some discharge from the ear when the patient was a child.

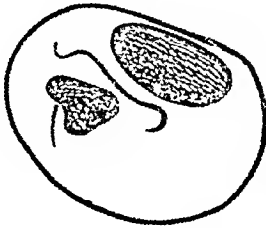
(2) Penicillin was started on rather empirical grounds and it was not until the second day of penicillin treatment that coagulase positive staphylococci and streptococci were isolated, though they had been constantly present in the smears.

(3) During the *first* penicillin course the following were noted:

- (a) The streptococci disappeared on the fourth day of treatment.
- (b) The staphylococci were cultured during practically the whole of this first course and persisted in the smears until after the second course of penicillin was started sixteen days later.
- (c) *Monilia* fungus appeared on the fourth day of treatment and persisted either in smear or culture until the end of the first course.
- (d) This first course was terminated owing to the occurrence of an acute otitis externa which coincided with the reappearance of "coliform" organisms. This acute otitis externa subsided with treatment but the "coliform" organisms remained for a further week after which they were temporarily banished by treatment with acid boric in spirit drops. With their disappearance, however, the streptococci and staphylococci again came on the scene.

(4) A *second* course of penicillin was now given in a mixed solution with equal part of 30 per cent sulphacetamide. The patient also received small doses of sulphathiazole by mouth (two tablets three times a day for one week). The following observations were made:

- (a) The staphylococci (coagulase positive) and streptococci disappeared during the third day of treatment and did not recur.
- (b) No acute otitis externa developed though some "coliform" organisms were grown on culture.
- (c) No *monilia* were seen in smear or culture.

 <p>Double Perforation.</p> <p>CHARACTER OF DISCHARGE: Moderate Mucopus</p>	TREATMENT.		No. of days.	BACTERIOLOGY START.	BACTERIOLOGY FINISH.	CLINICAL APPEARANCE START.	CLINICAL APPEARANCE FINISH.
	1. Intratympanic Syringing + Ac. Boric in Spirit Drops		21	Culture: "Coliform" B ++++ B. Subtilis +++++	Smear: Staphs ++ Diphtheroids ± Culture: Diphtheroids ++	Discharge ++ Grans ++	Discharge ++ Grans +
	2. Intratympanic Syringing + 30% Sulphacetamide + Sulphathiazole by mouth		7	Smear: Staphs ++ Diphtheroids +++ Culture: Diphtheroids ++	Smear: Staphs +++ Pus ++ Diphtheroids +++ Culture: Diphtheroids ++	Discharge ++ Grans +	Discharge ++ Grans +
	3. Intratympanic Syringing + Penicillin Instillation		10	Smear: Staphs +++ Pus ++ + Diphth. Culture: Diphtheroids +++	Smear: Pus +++ "Coliform" ++ Staphs ++ Monilia ± Culture: "Coliform" B ++++	Discharge ++ Grans +	Discharge ++ Grans ++
	4. Treatment to Acute Otitis Externa by Glycerine Icthyol and 1% Creosote and Thymol		4	Smear: Pus +++ "Coliform" ++ Staphs ++ Monilia ± Culture: "Coliform" B ++++	Smear: Pus +++ "Coliform" +++ Staphs +++ Culture: "Coliform" B ++++	Discharge ++ Grans ++	Discharge ++ Grans ++
	5. Intratympanic Syringing + Ac. Boric in Spirit		12	Smear: Pus +++ "Coliform" +++ Staphs +++ Culture: "Coliform" B ++++	Smear: Pus ++ Staphs ± Culture: Staphs + Streps +++	Discharge ++ Grans ++	Discharge + Grans ±
	6. Intratympanic Syringing + Penicillin Instillation 30% Sulphacetamide + Sulphathiazole by mouth		18	Smear: Pus ++ Staphs ± Culture: Staphs ± Streps +++	Smear: Pus +++ "Coliform" ± Culture: "Coliform" B ++	Discharge + Grans ±	Discharge + Grans +
<p>GRANULATIONS: Considerable. Attic Perforation</p> <p>DURATION: ?? 4 weeks</p>	7. Intratympanic Syringing + B.I. Powder Sulphonamide Powder		23	Smear: Pus +++ "Coliform" ++ Culture: "Coliform" B ++	Culture: Sterile	Discharge + Grans ±	Discharge — ve Grans ±

# Chronic Suppurative Otitis Media

(5) The "coliform" infection that remained was eventually cleared up with local sulphanilamide and boric iodine powder. The patient obtained a dry and sterile ear on discharge from hospital.

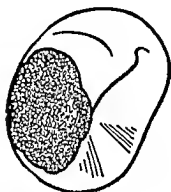
(6) The penicillin dosage was: first course, 22,000 Oxford units; second course, 27,000 Oxford units. Total, 49,000 Oxford units. The penicillin was applied by the Politzer bag and wick method.

## ABRIDGED CASE REPORTS.

The organisms printed in *italic type* are the ones which were found in the *initial cultures*.

FIG 2

### CASE 1



Posterior Perforation  
with Small Granulations

DURATION 7 years Discharge. Scanty Muco-purulent  
Granulations ++

ORGANISMS "COLIFORM", STAPHYLOCOCCI (COAGULASE  
NEGATIVE, and Coagulase Positive), Monilia

TREATMENTS Ac Boric in Spirit, Penicillin Local  
Sulphonamides

PENICILLIN Fistula Bag Method Dose 23,340 Oxford  
Units

RESULT An acute meatitis developed during treatment Staphylococci disappeared with Penicillin, but there was a temporary recurrence for several days after the cessation of treatment "Coliform" organisms were influenced by local Sulphonamides and Ac Boric in Spirit Drops Dry and sterile ear on discharge from Hospital

FIG 3

### CASE 2a



Large Fibrous Polyp in  
Central Perforation

LEFT EAR

DURATION 3½ years Discharge Profuse Muco-  
purulent Aural Polyp

ORGANISMS *B Proteus*, DIPHTHEROIDS, Staphylococci  
(Coagulase Positive), "Coliform", Monilia

TREATMENTS Ac Boric in Spirit, Sulphathiazole by  
Mouth, Removal of Aural Polyp, Penicillin, Local  
Sulphonamides, Penicillin + 30% Sulphacetamide,  
Ac Boric with Salicylic Acid Drops, Boric Iodine  
Powder

PENICILLIN Fistula Bag Method 1st Course Penicillin  
26,000 Oxford Units 2nd Course Penicillin + 30%  
Sulphacetamide 13,000 Oxford Units Total 39 000  
Units

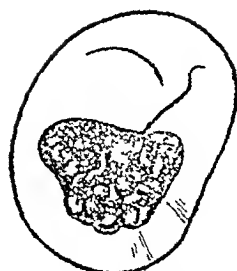
RESULT Staphylococci disappeared temporarily with Penicillin but recurred and were still present on discharge from Hospital Staphylococci were also possibly influenced by Sulphathiazole by the mouth "Coliform" organisms were influenced by local and general Sulphonamides On discharge from Hospital: Clinical improvement with some aural discharge still present



# E. G. Collins and K. E. A. Hughes

FIG 4

CASE 2b



Granulation Tissue  
Filling Perforation

RIGHT EAR

DURATION  $3\frac{1}{2}$  years Discharge Profuse Mucopurulent Granulations + + + +

ORGANISMS *B. Proteus*, DIPHTHEROIDS, Staphylococci (Coagulase Positive), "Coliform", Monilia

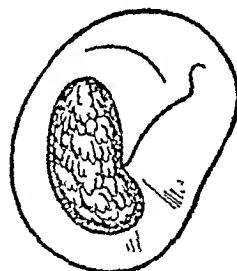
TREATMENTS Ac Boric in Spirit, Sulphathiazole by Mouth, Penicillin, Local Sulphonamides, Penicillin Ointment, Boric Iodine Powder, Penicillin + 30% Sulphacetamide

PENICILLIN Fistula Bag Method 1st Course Solution 26,000 Oxford Units Penicillin Ointment 12,000 Oxford Units 2nd Course Penicillin + 30% Sulphacetamide 13,000 Oxford Units Total 51,000 Units

RESULT As for the left ear On discharge from Hospital there was some clinical improvement with very slight aural discharge Granulations were still present in the middle ear

FIG 5

CASE 3



Sessile Polypoid  
Granulations

DURATION Childhood Discharge Profuse Mucopurulent Granulations + + +

ORGANISMS "COLIFORM", Staphylococci (Coagulase Positive), Streptococci, Monilia

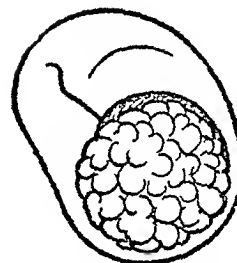
TREATMENTS Local Sulphonamides, Penicillin 1% Thymol and Creosote Operation + Penicillin-Sulphacetamide Mixture, Sulphonamide by Mouth (2 days), Boric Iodine Powder

PENICILLIN Methods (1) Fistula Bag, (2) Operation + Penicillin Perfusion 1st Course 29,000 Oxford Units 2nd Course 43,000 Oxford Units Total, 72,000 Oxford Units

RESULT An acute meatitis developed at the end of the first course, but not after the second Staphylococci disappeared with Penicillin Streptococci developed in mastoid cavity although Penicillin was filling it at the time, but they only remained for two days (Patient had a hæmolytic streptococcal throat at the time) 'Coliform' organisms were influenced by local Sulphonamides On discharge, ear dry and sterile with only small granulations present

FIG 6

CASE 5



Soft Fleshy Polyp  
Filling Perforation

DURATION Childhood Discharge Profuse Mucopurulent Aural Polyp

ORGANISMS MORPHOLOGICAL K L B (AVIRULENT), 'Coliform' Staphylococci (Coagulase Positive and Negative), Streptococci (few)

TREATMENTS Ac Boric in Spirit, Removal of Polyp, Penicillin Local Sulphonamides and General Sulphonamides (for a short time only), Boric Iodine Powder

PENICILLIN Fistula Bag Method 1st Course 30,000 Units 2nd Course, 22,000 Units Total, 52,000 Units

# Chronic Suppurative Otitis Media

**RESULT** An acute meatitis and dermatitis of external ear developed which was most probably due to Sulphonamide sensitivity. Penicillin brought about the disappearance of the morphological K L B (Diphtheroids) and Staphylococci and these did not recur after the second course. Coliform organisms were influenced slightly by Ac Boric in Spirit and Boric Iodine Powder.

On discharge from Hospital. Some clinical improvement but aural discharge still present and Coliform bacilli still present on Culture.

FIG 7

CASE 6



Anterior Perforation

**DURATION** 13 months Battle Casualty Discharge  
Profuse Muco purulent Granulations +

**ORGANISMS** SENSITIVE AND INSENSITIVE DIPHTHEROIDS  
Coliform Staphylococci (Coagulase Positive)

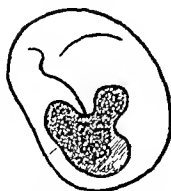
**TREATMENTS** Ac Boric in Spirit Penicillin + Sulpha-  
thiazole by mouth Local Sulphonamides

**PENICILLIN** Fistula Bag Method Dosage 30 000  
Oxford Units

**RESULT** Very mild otitis externa six days after Penicillin stopped ( Coliform ). The Diphtheroids disappeared after one day's treatment with Penicillin. The Coliform organisms responded well to local and general Sulphonamides. This ear might have cleared up with other methods. On discharge from Hospital Dry and bacteriologically sterile ear.

FIG 8

CASE 7



Antero Inferior  
Perforation with  
Marked Granulations

**DURATION** 6 years Discharge scanty Muco pus  
Granulations + + +

**ORGANISMS** *B. Proteus* STAPHYLOCOCCI (COAGULASE  
POSITIVE) Coliform

**TREATMENTS** Penicillin Local Sulphonamides Boric  
Iodine Powder

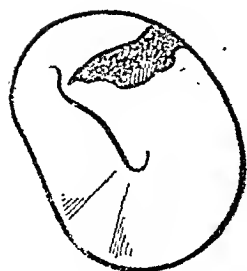
**PENICILLIN** Fistula Bag Method Dosage 31 680  
Oxford Units

**RESULT** Staphylococci disappeared after the first day's treatment but recurred six days later and still remain *B. Proteus* and Coliform influenced by local Sulphonamides. Slight moisture on discharge from Hospital but subsequent progress showed considerable clinical improvement though Staphylococci were still present on Culture two months after discharge from Hospital.

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FIG. 9.

CASE 8.



Postero-superior Marginal  
Perforation with small  
Granulations.

DURATION: 22 years. Discharge: Moderate thick  
Muco-pus. Granulations ++.

ORGANISMS: *B. Proteus*: Diphtheroids; (Staphylococci  
seen in Smears and said to have been isolated nine  
months previously). *Monilia* (Smear).

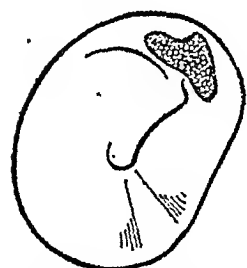
TREATMENTS: Ac. Boric in Spirit; Penicillin; Boric  
Iodine Powder.

PENICILLIN: Fistula Bag Method. Dosage: 24,620  
Oxford Units.

RESULT: Acute meatitis developed. *B. Proteus* and Staphylococci (Smear) unaffected by  
any form of treatment and on discharge from Hospital, ear condition remained  
"I.S.Q." both clinically and bacteriologically.

FIG. 10.

CASE 9.



Attic Perforation with  
Small Granulations.

DURATION: Childhood. Discharge: Moderate thick  
Muco-purulent. Granulations ++.

ORGANISMS: *B. Proteus*; Streptococci (Mastoid Antrum);  
Staphylococci; ? "Coliform"; *Monilia* (Mastoid).

TREATMENTS: Ac. Boric in Spirit; Boric Iodine Powder;  
Operation + Penicillin-Sulphacetamide Mixture;  
Local Sulphonamides.

PENICILLIN: Method: Operation + Penicillin Perfusion.  
Dose: 42,560 Oxford Units.

RESULT: No acute meatitis developed. The Streptococcus grown in broth from mastoid  
chips at operation disappeared immediately with Penicillin treatment. *Proteus*  
organisms became more like a "Coliform" bacillus but seemed unaffected to  
any extent by any form of treatment. On discharge from Hospital: Some  
clinical improvement with slight discharge only, but this was probably due to  
operative procedure. *B. Proteus* still present on Culture.

To summarize: Nine patients with chronic suppurative otitis media  
were treated by local applications of penicillin. Of these, four obtained  
a dry and sterile ear on discharge from hospital, and four showed some  
clinical improvement, which may have been due just as much to the  
intensity of treatment they received as to any local application of  
penicillin. One patient, who had a *B. proteus* in the aural discharge and  
where staphylococci were only seen in the smear showed no clinical  
improvement whatsoever. The dose of penicillin varied between 23,000  
and 72,000 Oxford units, but even as large a dose as 50,000 units was at  
times unsuccessful.

# Chronic Suppurative Otitis Media

## CONCLUSION.

The presence of the secondary organisms, such as the "coliform" bacilli, *B. proteus* and diphtheroids was undoubtedly one of the complicating factors limiting the successful treatment of chronic suppurative otitis media by penicillin. Florey has stated that penicillin is destroyed by the enzymes from many of the common bacteria and this includes the "coliform" group. If a large enough dose is given this handicap may be overcome, but there was no evidence of the disappearance of the gram-negative bacilli once the penicillin-sensitive staphylococci and streptococci had been abolished such as Jeffrey found in some of the war wounds. On the contrary, in this investigation, these gram-negative bacilli increased in quantity and there was frequently a flare up of the aural discharge with the production of an acute otitis externa of "coliform" origin. In an attempt to prevent this latter complication penicillin was combined with a solution of 30 per cent. sulphacetamide. This combination proved clinically successful, but bacteriologically the growth of "coliform" bacilli did not appear to be greatly inhibited. It is a matter of interest that in vitro tests failed to demonstrate any synergistic action between penicillin and sulphacetamide, as the mixture was no more potent than penicillin alone.

Our experience in this investigation would certainly suggest that these gram-negative bacilli are not always mere saprophytes but are often of definite ætiological importance in the persistence of the aural discharge. Instances are fairly numerous in the literature where "coliform" and proteus bacilli have been isolated from otitic brain abscesses or from the blood in an otitic septicæmia, and one of us has had such a patient under his care. Some interesting experimental work on the ætiological significance of *B. proteus* and related gram-negative bacilli in chronic suppurative otitis media has been done by Wirth of Heidelberg, and observations on the same subject have been made by Lang, Voss and Hesse.

Our own conclusion with regard to the local application of penicillin is that the results are definitely disappointing. This is not a condemnation of the value of local penicillin in general, but our comparative failure arises in part from the mechanical problem of getting penicillin into complete apposition with the diseased area. Furthermore, if any considerable mastoid disease or cholesteatoma exists, it is obviously unfair to expect penicillin to eradicate this. Penicillin-sensitive organisms are not a universal finding nor are they easily isolated, and for this reason the use of penicillin will be strictly limited in this disease. It is possible that its main value will prove to be in post-operative cases where definite penicillin sensitive organisms are present. The techniques used in this investigation require prolonged treatment by a trained otologist and from the Army point of view such methods of treating a disease which is so widespread do not appear to us to be practical.

(B) Penicillin Insensitive Group

We shall now deal with the second group of patients who received no penicillin and where no penicillin-sensitive organism was isolated. This group comprised fourteen patients and twelve of these were discharged with a clinically dry ear and with cultures from the middle ear which were either sterile or had a few skin organisms only present. This group provided an opportunity of assessing both clinically and bacteriologically the effects of some of the medicaments commonly employed in otology. At present, many medicaments are employed on empirical grounds or as the result of many years of clinical observation. This does not necessarily detract from their value, but it would be more satisfactory if their employment rested on a proved bactericidal basis. Before considering the effect of these drugs we should like to comment on toilet of the ear in general.

THE EFFECT OF CAREFUL TOILET.

The toilet of the ear was carried out by one of us personally and consisted of daily intra-tympanic syringing or dry mopping followed by suction with a Siegle's speculum. Every effort was made to provide aseptic conditions during treatment. These conditions were perhaps partly responsible for our obtaining 70 per cent. of dry and bacteriologically sterile ears on discharge from hospital and must be considered in evaluating any particular method of treatment. At the same time, the drugs employed did appear to contribute in a varying degree to the success of treatment and we should like to give our estimate of their effect both clinically and bacteriologically. It is along these same lines that other combinations of drugs are at present being tried.

THE EFFECT OF DRUGS IN THE TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA.

*Acid Boric in Spirit* (75 per cent.) was employed locally in sixteen of the patients and appeared to have a good bacteriological and clinical effect in about half of those patients from whose aural discharge diphtheroid or "coliform" bacilli were cultured. The proteus bacillus was only affected if the discharge was slight, and we would suggest that, when the proteus is a saprophyte, this solution will be effective owing to its dehydrating action, but that, when the proteus is a pathogen, it will not prove successful. The staphylococcus and streptococcus did not appear to be influenced to any extent either bacteriologically or clinically by this solution.

*Boric Iodine Powder*.—This powder was employed in nine patients and was also used as a prophylactic application in five other patients to try to prevent re-infection of the middle ear through a dry open perforation. The powder gave similar results to the acid boric in spirit drops through it appeared to be rather more effective, both clinically and bacteriologically, against the "coliform" bacillus. Its action against the proteus

## Chronic Suppurative Otitis Media

was very limited and when this organism was present it was necessary to apply the powder in large quantities. We again suggest that any success it achieved against the proteus bacillus was due to its power of absorption of moisture, as "dry" treatment was always more effective than "wet" treatment in this type of case. The staphylococcus was not usually affected by the powder but in one patient, who had not received benefit from penicillin, some clinical improvement was observed at the end of two months' treatment although the staphylococcus could still be grown on culture.

*The Local Application of Sulphonamides*—The local application of the following sulphonamides was tried. Sulphanilamide powder, Succinyl sulphathiazole powder, 30 per cent Sulphacetamide in solution and 15 per cent Mickraform Sulphathiazole in a cream suspension applied by the wick method. All of these had some effect on the "coliform" bacillus both clinically and bacteriologically. The best clinical results were obtained by the use of the Sulphanilamide powder and 15 per cent Mickraform Sulphathiazole. The sulphanilamide powder has the disadvantage that it tends to cake and sometimes irritates the meatus, but otherwise it appeared to be very effective against the "coliform" bacillus. Succinyl sulphathiazole is a very insoluble compound and for this reason it was not given an extensive trial as it appeared inadvisable to introduce such an insoluble substance through a perforation into the middle ear. The 15 per cent Mickraform Sulphathiazole was very nice to work with and left a very fine powder attached to the meatal wall and tympanic membrane when it dried. The sulphacetamide is the most neutral of the sulphonamides but probably the weakest in its action against "coliform" bacilli. It did appear, however, to exercise some effect. None of the sulphonamides used locally appeared to influence the proteus cases either clinically or bacteriologically. Staphylococci were unaffected bacteriologically by the application of micraform sulphathiazole for ten days in one patient though, clinically, there was rather less discharge and the general appearance improved. It is recognized that the prolonged local application of these drugs is contraindicated because of the danger of toxic manifestations.

*Peroral Sulphonamides*—Fairly large doses of sulphathiazole by mouth were given to ten patients. The sulphathiazole course consisted of 39 grammes extending over seven days. Four patients with "coliform" organisms in their aural discharge were given sulphathiazole by mouth combined with local treatment by intratympanic syringing and acid boric in spirit drops. Before the administration of sulphathiazole by mouth there had been only slow and gradual improvement in the amount of the aural discharge with the acid boric in spirit drops. About the fourth day after the sulphathiazole had been started, the ear became practically dry and by the end of the course the ears were sterile.

in each of the four patients. The ears remained in this condition up to the end of the investigation. Sulphathiazole by mouth was also given to three patients with a proteus infection. In one patient, where it was used in combination with mickraform sulphathiazole locally, it had the same good effect as was observed in the case of the patients with a "coliform" infection. In another patient, where it was used with boric acid in spirit drops, it produced no effect whatsoever. The third patient was Case No. 2, and here it is possible that in addition to having a beneficial effect on the proteus it had some effect also on the staphylococcus though a staphylococcus was not cultured at that stage. The effect of sulphathiazole by mouth on a diphtheroid infection was indefinite. Two patients appeared to be benefited, but in another patient it had no effect whatsoever. It will be a matter of opinion whether the use of this valuable drug is justifiable in chronic suppurative otitis media as there is a slight risk of sensitivity and agranulocytosis. Frequent blood and urine examinations were made in all the patients treated by this method. No toxic manifestations were observed. If the drug is used, it is considered that a short course with large doses will probably give better results than smaller doses over a long period and will be less dangerous.

In conclusion, we should like to emphasize that none of the successful cases are claimed as cures. Our object in presenting the results of this investigation is to introduce one further method of approach to this problem of chronic otitis media. Our own impression, so far, is that of all the bacilli found in the aural discharge, the staphylococcus and the proteus are our main enemies, and if these two organisms are in combination, they appear to be very intractable to treatment. There were seven failures in the two groups. Three of these were proteus infections, one a mixed proteus and staphylococcal and one a proteus and streptococcal infection. In the other two failures, staphylococci were cultured in one and diphtheroid and "coliform" bacilli in the other. Some other factors, such as the chronicity of the aural discharge; the presence of granulations in the middle ear; chronic infection of the mastoid and naso-pharyngeal sepsis all play their part in the persistence of the discharge. The bacteriology which we have found also suggests that the external route of infection may be more important than we imagine, and that more attention should be given to the prevention of re-infection of a dry open perforation by dirty water from washing or the screwing of dirty towels into the ears. These simple acts are of more common occurrence than the hazards of the swimming bath which have always been recognized.

#### Summary

(1) Twenty-three patients with chronic suppurative otitis media have been treated; nine of them by local applications of penicillin and the

# Chronic Suppurative Otitis Media

remainder by other methods. In four of the nine patients treated by penicillin, a dry and sterile ear was obtained, whilst in twelve of the remaining fourteen a similar result was achieved

(2) The percentage of successful cases was influenced by the bacteriology of the aural discharge and it is shown how this divided the patients into the two groups according to the sensitivity of the organisms to penicillin. It is considered that the bacteriology of chronic suppurative otitis media is an excellent example of antibiosis

(3) The techniques employed and the clinical and bacteriological effects of local applications of penicillin are illustrated by case records. The conclusion is drawn that the local use of penicillin will be limited in this disease owing to the types of organisms present and the difficulties of application. Furthermore, the use of penicillin demands prolonged treatment with hospitalization of the patient which would not prove a practical or economical procedure in the Army

(4) The group of patients with penicillin insensitive organisms in the aural discharge provided an opportunity to assess both the clinical and bacteriological effects of some other drugs which are commonly used in otology for the treatment of this disease and these receive brief discussion

(5) It should be emphasized that only the local application of penicillin has been tried and that the parenteral administration of this bacteriostatic agent has not been studied

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# THE USE OF AMNIOPLASTIN IN THE SURGERY OF THE EAR\*

By MAX SUGAR

AMNIOPLASTIN, or prepared amniotic membrane, has been used in surgery for a number of years. The first reference to the subject was made by Bürger, who used the whole amniotic sac to form the lining in the treatment of congenital aplasia of the vagina. He reported three cases in which he claimed extremely favourable results.

Others (P. Lafargue, M. Riviere, P. Caffier, L. Davies, L. J. Aries) reported similar experiences, there being some doubt as to the mode of action. The most generally accepted explanation being that epithelization proceeds with great rapidity under the protection of the membrane.

Prepared amniotic membrane was first used by Yi Cheng Chao, S. Humphreys and W. Penfield in their experiments. They separated the amniotic layer from the chorion and called it amnioplastin.

This preparation was used in experiments designed to show that amnioplastin was capable of preventing adhesions after lacerations of the cerebral cortex, being itself completely absorbed after a given period of about 30 days.

The membrane was used also for other purposes, as for replacing conjunctiva (Law and Philip), in peripheral nerve injuries (Rogers), and for preventing peritendinous adhesions (Pinkerton).

Reports regarding the efficacy of amnioplastin vary, but there seemed sufficient evidence in favour of the procedure to render it worthwhile to investigate its possibilities in otologic surgery. Having in mind the property of hastening epithelization, it was intended in particular to obtain information as to its usefulness in the post-operative treatment of the radical mastoid operation cavity.

Attention was focussed on three main points: (1) the ability of amnioplastin to achieve the main object of the radical operation, namely, a healed dry cavity; (2) the employment of amnioplastin to shorten the duration of post-operative treatment; and (3) comparison between amnioplastin and other methods of cavity treatment such as skin grafting.

## Preparation

The amnioplastin used in this series of operations was prepared according to the following method: The membranes were stripped from

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\* From the Nose, Throat and Ear Department under the charge of Dr I. Simson Hall, The Royal Infirmary, Edinburgh.

the placenta received from the Maternity Hospital in the Royal Infirmary. The membranes were then washed in water and the amnion separated from the chorion, adherent tags of chorion being cleaned thoroughly so that in the end a clean transparent membrane was obtained. This was washed in water and then soaked in acetone for 15 hours, after which it was rinsed in 70 per cent. alcohol for a few minutes in order to remove all the acetone. The somewhat hardened membrane was stretched afterwards upon rough towelling and dried. The dried sheets were cut into pieces of suitable shape and all discoloured and stained portions discarded. After soaking in ether for 12 hours and washing for a short time in 70 per cent. alcohol, they were dried in the open air for 24 hours. The sheets of prepared membrane were interleaved with grey filter paper, and boards to prevent warping were placed on top of, and underneath the pile of sheets. The whole, wrapped in a towel, was autoclaved for 10 minutes at 5 lb. pressure, followed by vacuum 5 lb. for another 10 minutes. The sheets were then ready for use.

It was found that their use in this dry state was preferable to using them after having been dipped in saline, as they were easier to handle. Manufactured amnioplastin was tried instead of the hospital-made material, but it was given up after a few trials. Apart from the high cost, the manufactured leaves were usually too small for the purpose, and very sticky. Whenever they came in contact with moisture (blood, saline or water) they adhered to the fingers or the instruments and could be separated only with difficulty.

### Method of Use

After the mastoid operation had been carried out, the cavity was packed with iodoform paraffin gauze, and the retro-auricular wound sutured. Eight, ten, or twelve days after the operation, the packing was removed and the cavity repacked with sterile gauze soaked in peroxide of hydrogen, for hæmostasis. The retro-auricular wound was reopened and after hæmostasis was complete, flexible warm Stent was inserted in the cavity with pressure until every part had been filled up with the material. Two pieces of Stent were used, in each of which, when still in soft condition, a silk thread was imbedded, in order to secure easy removal through the meatus about a week after the insertion. The two pieces of Stent were hardened by submerging in cold water, and wrapped in a prepared piece of amnioplastin, care being taken that one end of the membrane protruded through the meatus and covered the raw surface near it. After this the two threads were drawn through the meatus, a small pack was inserted in order to plug the meatus and secure the stability of the Stent, and the retro-auricular wound was sutured. Eight or ten days later the Stent was pulled out with the help of the threads through the meatus.

# Max Sugar

## After Treatment

The cavity, in most cases, looked smooth and glossy and gave the impression of having been covered by a transparent mucous membrane. The original granulations appeared to be flattened out and little discharge was present. The cavity was repacked with iodoform gauze soaked in liquid paraffin and the dressing changed every day. The further course differed according to the various reactions in the patients. In some patients it was possible to change after a few packings to iodine-boracic powder insufflation (0.75 per cent. iodine in boric acid powder). These showed exceptionally good healing without granulation formation. In others the impression was obtained that the cavity tended to narrow through the underlying granulations, which, however, always appeared to be covered by the membrane, which prevented them from becoming exuberant.

These cases required packing over a longer period in order to keep down the granulations.

In another group, where infection seemed to have set in, there was profuse discharge and formation of granulations, but even in these cases, it seemed that there was less tendency to pocket-formation or formation of large granulations, than in similar cases treated without amnioplastin.

When, at the insertion of the Stent, there was a tendency to increased formation of granulations, the Stent was left for about 12 days and in these cases the hard Stent mass seemed to have kept down the granulations by pressure. Usually after 12 days healing had so far proceeded that there was less danger of profuse formation of granulations.

The membrane could easily be followed up until the third or fourth week, after which normal epithelization set in. Although great care was taken with the after-treatment, patients being seen daily, it could not be determined whether epithelization had started before the complete disappearance of the membrane or not. All that could be said was, that from one day to another secretion diminished markedly and became somewhat thicker until it stopped altogether. When the secretion began to decrease, the walls of the cavity became smooth and ultimately looked like scar tissue, shedding after a short while a thin membrane, which marked the complete healing.

To investigate the nature of the lining of the cavity after healing had taken place, a portion was removed and submitted to histological examination. The pathologist reported that "the specimen consists of fibrous tissue covered by a thin layer of squamous epithelium. The fibrous tissue is fairly cellular and also shows the presence of a number of capillaries around which there is a variable infiltration with round cells".

In other words, there was no special character as regards the lining in such a case, but the appearance resembled those of any other healed mastoid cavity.

# Amnioplastin in the Surgery of the Ear

## Difficulties Encountered

Difficulties in treatment and healing were encountered in two types of cases. In the first were those with a big central perforation with continued secretion of the middle ear. Although the remains of the drum were bridged over by amnioplastin, it was seen, that the membrane had disappeared over the perforation, and discharge continued. In order to obtain cavities dry they had to be treated along the lines usual in cases of chronic otitis. The second group contained a few cases in which, after the modified radical operation had been carried out, the drum, deprived of its posterior attachment and support, had fallen forward and outward. Because of this, a pocket had formed, the roof of which was the attic, the floor the drum, and partly the malleus. This pocket was soon a bed of granulations, which were very difficult to deal with.

Those cases still showing discharge belong to this group.

To avoid this pocket formation in the later cases a flap was cut from the posterior meatal wall, continuous with Shrapnell's membrane and after the operation was completed the flap was turned into the cavity. Two advantages were gained. Firstly, pocket formation was prevented from the beginning, and secondly, the bare area of the operation cavity was reduced. The results in these cases were very satisfactory.

## Results of Treatment

The following is a short survey of the first 24 cases, out of which more than half were operated upon before the improved technique had been applied.

NUMBER OF CASES 24  
20 Modified Radical Mastoid Operations  
4 Radical Mastoid Operations

Age in Years	Duration of Disease	Duration of Treatment	Dry	Discharging	Lost touch with
7 54	6 months 34 years	16 28 days	18	5	1

The object in treatment is to obtain in as short a period as possible such a degree of healing that the patient can be discharged from hospital with confidence that a dry cavity will shortly be obtained. This stage, as has been shown, has been reached in the most favourable case in 16 days, but in the average case in three to four weeks.

## Conclusions

Using amnioplastin it appears that a dry cavity can be obtained in a high (75 per cent) percentage of cases. It would also seem that the post-operative period is shortened by the use of amnioplastin, and it

# Max Sugar

simplifies the post-operative treatment by eliminating the cutting of grafts and the healing of denuded areas.

## Summary

Prepared amniotic membrane has been introduced as a method of covering the wound cavity after the radical mastoid operation.

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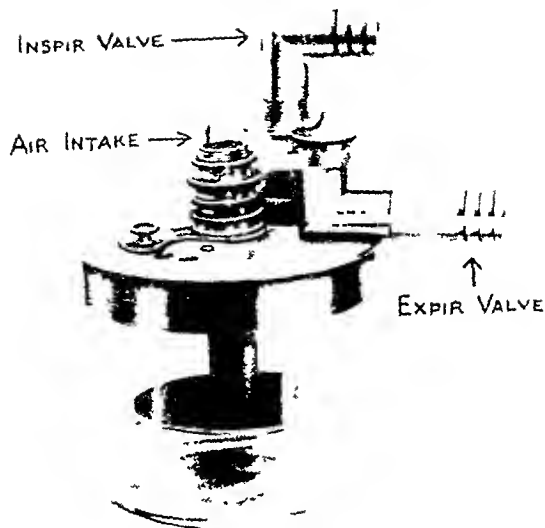


FIG. 1.  
Sketch of apparatus.



FIG. 2  
X-ray view showing apparatus in position

# AN AUTO-ANÆSTHETIC APPARATUS SUITABLE FOR EAR, NOSE AND THROAT WORK

By T. B. JOBSON (Guildford)

THE apparatus consisted of a glass container  $3\frac{1}{2}$  in. high and 4 in. in diameter, the tight-fitting metal lid had a central opening through which a metal tube projected to the bottom of the container. Air entered through this tube, passed to the bottom and bubbled up through the ether. Above the other opening in the lid was an inspiratory valve. Through a rubber tube attached to the top of the inspiratory valve the ether vapour was inhaled by the patient. The expired air passed from the patient through another rubber tube to an expiratory valve fixed on the lid of the container. The throat-piece was a wide fully-curved flattened metal tube, the distal end of which lay over the larynx. The bifid anterior end was attached to the inspiratory and expiratory tubes.

For nose cases the patient was first anæsthetized with ether on an open mask. When the pharyngeal reflex was abolished the throat-piece was slipped in and the pharynx was packed off with 8 in. gauze, damped with a vegetable oil. This prevented any secretion getting into the lung. The throat-piece kept the tongue forward and ensured a clear airway, the patient would now anæsthetize himself and continue to do so as long as necessary.

For tonsil dissection a Y-metal attachment was used to connect the endotracheal catheter with the two rubber tubes leading to the anæsthetic apparatus. The pharynx was packed off in the usual way.

The advantages of the apparatus were :

- (1) Very great safety and simplicity.
- (2) Protection of the lungs from inhaled secretion.
- (3) A clear airway all the time.
- (4) Elimination of forced oxygen inhalation (prolonged high concentration of oxygen was unnecessary and dangerous).\*
- (5) Convenience and portability—the weight was 2 lb. 12 oz., compared with 75 lb. of the portable Boyle's apparatus.
- (6) Very useful when operating at small hospitals where a skilled anæsthetist is not available.

The apparatus is made by Mr. Charles King, London.

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\* *Anesthesia and Analgesia*, September-October, 1938, p. 242



# SOCIETIES' PROCEEDINGS

## ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY WITH SECTION OF ANÆSTHETICS

February 4th, 1944

### JOINT DISCUSSION No. 3

*Chairman*—W. M. MOLLISON, M.Ch. (President of Section of Laryngology).

### Discussion on Bronchoscopy in the Prevention and Treatment of Traumatic and Post-operative Pulmonary Lesions

LIEUT.-COLONEL NORTON CANFIELD, U.S.A.M.C.

SOMETIMES when a patient makes unsatisfactory progress or some unusual features develop, the explanation may be a pre-existing foreign body, a benign or malignant growth, or a chronic infectious pneumonitis. Here the bronchoscopist should be able to clear the picture by a single examination. One case was that of a woman who carried a piece of beef bone in her right main bronchus for eleven months, obscured in the X-ray by the heart shadow. Realizing the possibility of a foreign body she was examined and removal of the bone allowed the lung to clear. I once removed some roots of grass from the left main bronchus of a child who injured her chest and was thought to have a resulting empyema. The clearing of the airway was followed by recovery. Unsuspected tumour masses may block a bronchus after injury and a complicated course ensue. Bronchoscopy here is essential and can often settle the diagnosis.

Before operation additional knowledge of the tracheobronchial tree can be obtained by bronchoscopy. With a patient in good surgical condition the procedure is seldom contra-indicated, but following serious or extensive operations, it may be extremely hazardous to subject a patient to the medication and manipulation necessary for bronchoscopy in order to rule out a hitherto unsuspected lesion. Times of operation can be better judged with complete knowledge of the tracheobronchial mucosa as revealed by bronchoscopy.

*Post-operative complications.*—The dreaded post-operative pneumonia followed by lung abscess has yielded to procedures initiated if not, in fact, actually done by the bronchoscopist. Ever since the recognition that most post-operative lung complications originate from bronchial obstruction, and consequent atelectasis, bronchoscopic methods have played a prominent part in therapy. Many post-operative bronchial obstructions can be relieved by non-bronchoscopic methods. Catheter suction, coughing, breathing of carbon dioxide mixtures and movement of the patient may suffice in most cases, but when these fail, manipulation of the bronchial tree with a rigid instrument and aspiration of secretions have been followed in many cases by proper aeration of the peripheral lung tissue. In my experience these mucous plugs cannot be

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removed as discrete masses of tenacious mucus because the suction tubes destroy their form when they are aspirated. That they do act as a plug in the bronchi is hardly to be doubted, however, because of the resulting atelectasis and the prompt re-aeration following aspiration. The radiographs do not clear as quickly as the clinical picture probably because of the peribronchial cellular reaction which causes the radio opacity to persist longer than the bronchial obstruction. Following a long or serious operation the advent of a pulmonary complication may seem to be a contra-indication to further manipulation, but the rapid improvement after clearing the airway is ample justification for the procedure. The patient need not be removed from his room or bed. If catheter suction is of no avail bronchoscopic aspiration should be done without the hazard of unduly moving the patient on to an operating table and back to the operating room. With the patient diagonally across the bed and the head in high extended position the aspiration can be easily and expeditiously performed.

One of my most dramatic cases followed a tonsillectomy under local procaine anaesthesia. The bleeding was slight during the operation and none occurred thereafter. Eight hours following operation the patient was reacting from the narcosis and had difficulty in taking a deep breath. The right chest was dull to percussion and no sputum was being raised. Coughing was encouraged and 5 per cent carbon dioxide in 95 per cent oxygen was used in an attempt to deepen the breathing. As this was unsuccessful bronchoscopic aspiration was performed and prompt aeration of the right lung ensued, with no further complication. I believe this patient's post-operative narcosis was too deep. It had been induced by phenobarbital-sodium and morphine. The cough reflex was depressed and there was no urge to remove the pulmonary secretions.

The question of narcosis in wartime presents a consideration not usually seen in civilian practice. Men exposed to cold require more morphine for relief of pain. However, when they are evacuated to a warm shelter the drug acts as if it had been stored and becomes available for body distribution. The narcosis thus deepens and the cough reflex is depressed. This series of events is thought by some to favour the advent of atelectasis in wounded men and is undoubtedly a contributing factor in some cases seen in military hospitals.

*Post operative lung abscess*—Believing, as many do, that post-operative lung abscess is a sequel of post operative atelectasis, I consider that early bronchoscopy is indicated. In patients up to 30 years of age most lung abscesses resolve with rest and postural drainage. Bronchoscopic aspiration is of no assistance in many cases.

During aspiration in cases of lung abscess deep narcosis and general anaesthetics are contra indicated because coughing during the manipulation is of utmost importance. Only enough analgesic should be used to control the larynx. The abscess is seldom actually reached with the bronchoscope or the aspiration tube, but the sponge-like action of the lungs forces the pus into the bronchus during expiration. If the aspirating tube can then catch the pus before it is sucked back into the abscess much of the actual contents can be removed by repetition of this process. Hence the necessity for maintaining the cough reflex intact. If a series of six or eight aspirations performed about

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twice a week is not followed by noticeable clinical improvement, this treatment should be discontinued.

*Pulmonary medication.*—Normal saline is quickly absorbed through the lung. In cases of crusting of tracheal and bronchial tubes in severe acute infection in children, I have often used five to twenty cubic centimeters of saline solution to loosen the crusts with good results.

An injured person may have such pain that bronchoscopy may be inadvisable, but in chest injuries there must be no excuse for leaving the airway blocked by secretion and blood. Medical officers in the African Theatre of Operations have seen many chest injury cases and have used the method of intercostal nerve block to control pain. The injections are made in the paravertebral line just beneath the rib tubercle and include one rib above and one below those involved in the lesion. This allows the patient to cough without pain. If coughing does not remove secretions bronchoscopy can then be used without discomfort. With the clearing of the lungs healing is rapid and pain often does not recur.

*Blast injuries of the lung.*—In blast injuries to the chest, the patient may not be disabled at once but pulmonary symptoms develop insidiously and he may collapse from respiratory insufficiency. Bleeding from the mouth and nose indicates injury to the respiratory tract and study of these cases has shown the lesions to be in the bronchi and lung tissue. Bronchial obstruction sometimes develops with consequent pulmonary insufficiency. Reports of such cases have come from our colleagues during the air raids in this country and from medical officers in the African and Italian Campaigns. Such cases need attention to the airway when it does not clear spontaneously, to prevent extensive lung damage by supervening infection. Wounds of the chest cause extensive damage which is indicated by expectoration of blood and mucus. After attention to the chest wall the airway may require clearing and again the possibility of bronchoscopic procedures may have therapeutic importance.

So far there have come to our attention very few cases of poison gas casualties, but the pathological lesions are well known. As far as I am aware, no human beings have benefited by tracheobronchial manipulations in cases of irritant gas poisoning. Experimental work on animals has been encouraging but no work on human beings has been done to my knowledge. The vesicants, however, produce lesions very similar to those found in severe infections of the tracheobronchial mucosa. A necrosing desquamation produces destructive plugs with consequent bronchial occlusion and atelectasis. Removal of these plugs has cleared the airway in patients and arrangements have been made for providing this treatment in gas casualties. Our present methods may need to be improved, but to be aware of the possibilities for removal of the plugs should these cases occur is the responsibility of the bronchoscopist. The chemicals affect the larynx, causing ulceration and edema. This may preclude peroral endoscopy but low tracheobronchoscopy through a tracheal stoma may be a life-saving procedure. In such severe lesions as do occur in gas casualties access to the lower trachea and bronchi is much easier with a short endoscope or even certain types of laryngoscope than with the longer tubes used by the peroral route. Tracheobronchial irrigation with saline facilitates the removal of crusts. Even without endoscopes of any type I

believe that the tracheobronchial tree is accessible through a large tracheal stoma. Crusts can be removed with forceps, coughing, and the help of irrigating solutions.

## M D NOSWORTHY (*Abstract*)

The value of bronchoscopy for the removal of foreign bodies and as part of the treatment of lung abscess is unquestioned, yet, when a patient has aspirated vomit during anaesthesia, early bronchoscopy to save him from developing a lung abscess is seldom put into practice.

Negus, in 1933 (1), pointed out that the laryngeal and cough reflexes, ciliary action and the presence of mucus in the right quantity and of the right quality were the factors which guarded the entrance and prevented infection from gaining a foothold in the lower respiratory tract. The action of belladonna derivatives, sedative drugs and anaesthetic agents, and the effects of operation, injury, or accident strain and sometimes overwhelm these natural defences.

Let us consider the causes for the accumulation of secretions in the bronchial tree and the reasons why the patient cannot get rid of them. The depressant effect of anaesthetics on ciliary action and their influence upon the mucus carpeting the bronchial tree is of the first importance. Repeated injections of atropine and mixtures containing belladonna make the secretions viscid, and shallow breathing favours their stagnation. The bronchial secretions will be increased by the spread of infection from the upper respiratory tract or by one originating in the lungs themselves. The folly of operating upon a patient only just recovering from a cold or sore throat is now generally realized. The copious secretions produced by stimulant cough mixtures tend to drown a patient whose cough reflex is ineffective. The inhalation of irritant gases or vapours, or the aspiration of vomit, particularly of a vegetable nature, will have the same effect. The irritant qualities of ether are somewhat offset by its properties of relaxing the bronchial musculature and thinning secretions. Respiratory obstruction or cardiac failure may render the respiratory tract oedematous. There may be a great outpouring of mucus following upon a difficult thyroidectomy and a similar condition after thymectomy in a patient taking prostigmine. Finally, blood may be inhaled after injuries or while a patient is under the influence of an anaesthetic, or it may accumulate as a result of wounds involving the lung.

When a cough and laryngeal reflexes are depressed by the patient's low vitality or by the action of narcotic drugs the respiratory tract is very vulnerable. Not only is there the risk of aspiration of foreign material but also secretions already present may allow organisms to flourish, or may cause bronchial obstruction. This state often follows cerebral operations and even relatively minor injuries in debilitated subjects. Effective methods for the prevention of aspiration, although well known, are too often neglected.

There are many reasons why the cough reflex, although active, may be incapable of clearing the tracheobronchial tree. In the first place a patient propped upright in bed has to cough sputum uphill all the way, and, if the secretions are tenacious or copious, an ill man may well become exhausted before he has effected a clearance. The sputum then falls back and he has to start all over again. After secretions have been in contact with the same area

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of mucous membrane for any length of time that area becomes insensitive ; the urge to cough then disappears but the signs of respiratory obstruction remain. If pain is felt at the site of injury or operation on breathing deeply the patient is naturally disinclined to do this, and he may refuse to cough at all or only makes a half-hearted attempt. This is one of the chief reasons for the relatively high incidence of pulmonary complications in patients with abdominal or thoracic wounds. Pain and paradoxical respiration may make the cough inefficient when the thoracic cage has lost its stability. This occurs with a " stove-in " chest from fractured ribs and is also sometimes seen after thoracoplasty. In like fashion, after certain operations on the larynx or when the recurrent nerves have been damaged during a thyroidectomy, the patient is unable to build up an effective pressure to produce an expulsive cough. In these last conditions a tracheotomy is commonly performed and, although in no way improving the power to cough, it relieves respiratory obstruction and provides a ready means for the aspiration of excess secretions.

Unless removed, retained secretions may kill a patient by asphyxia, or may be responsible for atelectasis, pulmonary suppuration or bronchopneumonia. After operation or injury it is important, at frequent intervals, to make sure that the patient can, and does, take a series of deep breaths and cough. This opens up sticky alveoli and keeps secretions on the move. He must also be encouraged to change the position in which he is lying ; if he cannot do this himself, his posture must still be changed ; a patient must not be left lying for hours undisturbed. Often a patient who is apparently still unconscious can be roused up to breathe deeply and cough on command. These measures constitute the " stir-up " régime advocated by Waters (2). An unstable chest-wall must be firmly strapped or fixed by layers of plaster of Paris. Regularly laying the patient down flat and posturing him first on one side and then on the other is most important because not only does this help the drainage of secretions, but it also assists expectoration. Morphine eases the pain of coughing and is therefore of value ; individualized dosage and the stir-up régime offset its depressant action. Inhalations of friar's balsam or a mixture containing potassium iodide help to loosen tenacious secretions. A simple emetic is a very effective method of clearing the bronchial tree of a child. If secretions accumulate in spite of these measures—or straightaway in cases of urgency—aspiration therapy gives very gratifying results and saves the patient much discomfort. This treatment may have to be repeated.

It is now generally accepted that atelectasis is due to bronchial occlusion, the air in the portion of lung so isolated being slowly absorbed—from alveoli filled with oxygen or anæsthetic gases absorption takes place very quickly. Occasionally, bronchoscopy reveals occlusion by pressure from enlarged mediastinal glands, or obstruction by an inhaled tooth or by a tumour filling the bronchial lumen. In the vast majority of cases retained secretion is the cause, prophylactic measures having been neglected or unsuccessful. Sometimes spasm of the bronchial musculature during anæsthesia, by closing down the lumen on a small lump of mucus, may be the determining factor in converting a partial into a complete obstruction. To those unfamiliar with modern views on post-operative pulmonary complications I suggest a study of Brock's (3) classical contribution to the subject and also the other writings to which

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reference is made. Two clinical types of atelectasis may be recognized, in one the patient is acutely ill, in the other he eats and sleeps well and is not distressed by it. In both traumatic and post-operative cases, re-expansion soon takes place in the latter group with simple postural treatment assisted by hand-clapping over the affected area. A similar response is also shown by the majority of patients in the former group, but not by all. Sepsis in the pleural cavity adversely affects the prognosis and delays re-expansion. When improvement in the condition of an ill patient does not take place quickly more drastic treatment is called for, as a safeguard against pulmonary suppuration, bronchopneumonia, or the later development of bronchiectasis. Some advise bronchoscopy on all patients as soon as the diagnosis of atelectasis is made. I think that this is wrong and, like the routine use of endotracheal anaesthesia introduces an unnecessary complication. Aspiration is, however, a valuable procedure, and should be carried out as soon as the indications for it arise which often means late at night. Whether clearance is better effected by bronchoscopic aspiration or by "blind" methods of suction is a matter for discussion.

I have myself followed the practice championed by Waters (4), and first pass a wide-bored Magill endotracheal tube to permit the free ingress of air while suction is being applied to a catheter introduced through its lumen, in fact, a similar "set-up" to that used for aspiration during, or at the end of, operation. Gillespie (5) reminds us that Kuhn (6) used this method for removing excess secretions as long ago as 1912. Following the Madison practice, I have found that a portable outfit complete with everything required for cocainization, intubation, and suction is a great convenience\*. Intubation under local anaesthesia is the method of choice. If the exact procedure and the benefit likely to be derived from it are explained to them beforehand most patients willingly co-operate. I formerly gave the patient the original decain tablet to suck before spraying the nose and throat with 2 per cent butyn or with 10 or 20 per cent cocaine. The present anethaine tablet must not be used in this way or stomatitis will result. Two anethaine tablets dissolved in an ounce of water may be usefully given, however, as a gargle, if the patient is able. The thoroughness with which the topical application must be applied varies with the individual, if cocainization is incomplete for a fit patient gross laryngeal spasm will occur on intubation, resulting in an alarming degree of anoxia.

If the nasal cavity will accommodate a sufficiently large tube I usually perform blind nasal intubation. For a young man who has a full set of teeth and a large muscular tongue this is less uncomfortable than laryngoscopy, although it never fails to surprise me how easy it usually is to expose the glottis of a patient sitting propped up in bed. A lubricated rubber or Coudé catheter is then introduced, and moved up and down inside the endotracheal tube while suction is applied, the possible risk of occluding one of the smaller bronchi, and deflating the area of lung supplied by it, is avoided by taking care not to introduce the catheter too deeply and by keeping it constantly on the move.

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\* Supplied by Medical & Industrial Equipment Co. Ltd., 12 New Cavendish Street, London, W. 1

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this patient about half an hour after the incident and by immediate bronchoscopy removed quantities of blood and mucus with relief of symptoms. The tear in the posterior tracheal wall was also inspected. At a later date a bilateral atelectasis developed which was treated by bronchoscopy in addition to postural drainage and within a few weeks the chest was virtually normal. This case illustrated two phases of bronchoscopic treatment: one, the removal of secretions in the state of severe shock, and the other when massive collapse had started.

When the actual practice of chest surgery is considered the use of the bronchoscope could be discussed in three stages. First, there was the pre-operative phase in which the bronchoscope was really required as an adjunct to postural drainage which was not completely effective. The procedure might have to be carried out at the actual start of the operation if, on anæsthetic induction or on movement, a patient with plenty of sputum suddenly showed signs of respiratory obstruction. In this event suction and clearing of the air-tubes was very important before starting the actual operation. Chest patients were usually lying in the "good" lung, and that was the side that was liable to be flooded. He recalled the case of a young child with extensive bronchiectasis who was thought to have an adherent pleural cavity. However the lung was free and on incision of the pleura the lung collapsed suddenly. This dislodged pus which passed into the opposite side and, even though the bronchoscope was passed within forty-five to sixty seconds, the fluid had gone beyond the range of the suction tube. The child died from drowning.

During operation he did not think that any chest surgeon would work without a bronchoscope at his elbow. Manipulation of lung may extrude pus and secretions into the main bronchi and if these were dispersed into the dependent air-tubes serious respiratory embarrassment would follow. The obstructive signs came on quite silently in many cases and could easily be overlooked. Sometimes the patient's colour appeared good owing to the high concentration of oxygen in the anæsthetic, and, in spite of this, anoxia developed. The only indication of this might be a slowing of the pulse-rate. On occasions the course of an intrathoracic operation had to be interrupted so that the patient could be bronchoscoped to ensure that the bronchi were free from any obstructing material. This can undoubtedly be a life-saving measure, although a disturbance to normal operating technique, and it should only be used if simple blind intratracheal suction failed. Bronchus blocking was commonly used in intrathoracic work to avoid flooding of the "good" lung, but unexpected hæmorrhages or some technical difficulty in blocking did not always obviate the dangers described.

At the end of the operation it was a wise move to make quite sure that the bronchi were free from loose secretions and, if there were any, to remove them by suction. The method was not of much importance so long as the technique was within the capacity of the operator, but the advantage of bronchoscopy was that it could ensure that each of the major air-tubes was clear. It was slightly more satisfactory, though more disturbing, than working blindly with a catheter.

In late complications the value of bronchoscopy was more disputed. In a case of early pulmonary collapse aspiration could be used, but it was of little

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value after the first few hours had passed because the damage would have been done as the mucus and foreign material had descended beyond the range of the bronchoscope. Cases which were bronchoscoped without delay often recovered dramatically and rapidly, and a fully aerated lung could be anticipated in a high proportion of them.

The more senior members of the team who could use either bronchoscopy or "blind" intubation preferred the former. The junior members were trained to use blind intratracheal methods and with comparatively short practice obtained considerable dexterity. He held that only the minimum of preliminary local anaesthetization was necessary. The use of pentothal in a "wet" case was felt to be dangerous, early relaxation followed by dislodging of secretion led to some obstruction with resultant spasm and it might become impossible to pass the bronchoscope. The development of blind intubation had certainly enlarged the potential field for endobronchial aspiration and the method was one that had considerable advantages when prolonged or continuous suction was likely to be required. In the absence of a skilled endoscopist who might prefer to use a bronchoscope, the "blind" method did not have the same dangers of bronchial trauma or disturbance to a distressed patient.

V E NEGUS said that he could add his testimony to the evidence which had been given concerning the value of bronchoscopy.

The whole problem was one of bronchial obstruction, whether by foreign body, by growth, or in warfare, by a piece of metal. If for any reason there was blockage of a bronchus, infection would occur with subsequent suppuration. Liquid blood did not do much harm. It had been pointed out by different observers that a certain amount of blood got in in many tonsillectomies, with little harm. But with clots it was a different matter. A clot coming from the tooth or tonsil area was infected, and was more important than liquid blood. Every breath taken must mean that organisms were carried down. Some of them were caught in the nose, but many reached the bronchial tree. Usually they were removed by ciliary action, and this was of great importance. The cilia could not work if the bronchioles were blocked by mucus or a foreign body, nor could they work if the mucus was dried up by excessive amounts of atropin.

R C BROCK said that it was important to consider how often aspiration of the bronchial tree was really needed. He saw many cases of post-operative chest complications and it was often not a question of deciding between the use of bronchoscopy or aspiration by a catheter, but of the complete neglect of the ordinary simple methods of preventing retention of secretion. He was often asked urgently to bronchoscope a patient with atelectasis and audible bubbling of secretion in the trachea, and yet no postural drainage of any sort had been used, as Dr Nosworthy had already said most clearly, the first, second and third line of defence was the routine use of posture and simple methods both to prevent atelectasis occurring, or when it had occurred to get the patient to cough his sputum up by himself. If these simple methods were used the problem of bronchial aspiration would rarely arise. He insisted that all his cases, abdominal and thoracic, were turned flat on their side at least twice a day and urged to cough. Sometimes it might not be possible to do this drill, but when it was done properly and conscientiously, perhaps with the



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surgeon helping on the first occasion in a difficult case, a great deal of post-operative chest trouble would be prevented.

A number of patients suffered a true pneumonic condition from the start of the post-operative period and it was very difficult at times to decide whether a patient had got simple atelectasis or a condition much more serious. There was a proportion of patients, particularly the debilitated, elderly or very sick, in whom the pulmonary complication was grave from the beginning and was almost certain to prove fatal whatever was done. Inhalation of vomit, for instance, might produce severe irreversible changes in the lung in addition to atelectasis, and aspiration of the bronchi would achieve little. A patient with a severe pneumonia might be made worse by bronchoscopy. He was fully in agreement with the views expressed as to the value of bronchoscopy and of catheter suction in selected cases, but suction was not without danger both during operation and in the post-operative phase. Excessive suction could produce the complete and rapid deflation of a whole lobe or even a whole lung. The over-enthusiastic or over-conscientious anaesthetist could do a great deal of harm in this way.

W. W. MUSHIN said that the Nuffield Department of Anaesthetics at Oxford kept careful records of all patients during the post-operative period. Atelectasis or collapse of part of the lung was not diagnosed unless there was good clinical evidence and usually good X-ray evidence as well. The examination of the patient and the diagnosis of this condition were made by a senior member of the anaesthetic department, and assistants in that department were taught the methods of examination and diagnosis of these chest conditions. Tracheal suction had been done on a number of these patients, and certain tentative conclusions had been reached about its value.

The great majority of the patients who had atelectasis would get better of their own accord if encouraged to undertake breathing exercises, cough vigorously, move about in bed, and to use posture as an aid to drainage. The more robust the patient the more likely he was to recover with this treatment. A feeble patient or one who was debilitated by his original disease or as the result of a prolonged shock-producing operation was the sort of patient who was likely to get a secondary infection on top of the atelectasis and develop bronchopneumonia. If a patient was of this clinical type, or the involvement of the lung with the collapse was sufficient to cause dyspnoea and a respiratory rate of 30 or 40 or even more a minute, and if he had cyanosis as well as tachycardia and high temperature, tracheal suction should be done without hesitation. The majority of these patients showed signs of recovery within the next two to four days.

Another group of patients in whom tracheal suction had proved most beneficial and of great immediate relief to the patient himself were those who had a quantity of secretion retained in the trachea or bronchi. These were usually elderly people in poor condition who had had a chronic bronchitis before operation and this had become exacerbated as a result of having an intra-abdominal operation. The vast majority of the tracheal suction for post-operative complications had been done by lightly cocaineizing the pharynx and nose with a spray, and passing a small rubber endotracheal tube blindly through the nose into the trachea. Through this was passed a well-greased

gum elastic suction catheter long enough to reach beyond the bifurcation of the trachea. The initial spasm of coughing produced by passing the rubber tube soon ceased and suction could then be done deliberately. Large amounts of secretion were often removed this way, and even those patients with little free secretion seemed to benefit from the procedure. It did not require any premedication and was done in the patient's bed.

There were thus two main types of patient in whom this type of tracheal suction might be done post-operatively: (1) those who, even in the absence of clinical signs of atelectasis, had abundant and obvious secretion in the trachea and bronchi which they could not get up, (2) those who were diagnosed clinically and radiologically as having atelectasis and did not seem to have a sufficiently robust physique to cure themselves by breathing exercises and coughing, and who might otherwise develop bronchopneumonia.

MAJOR R. A. GORDON, R.C.A.M.C., described two cases which represented (1) a type which had not been mentioned in the discussion, and (2) a case of post-operative complication in a patient who had been severely wounded.

The first patient had a severe head injury. Many such patients had a much depressed or absent cough reflex, and they were difficult nursing problems. Frequently these patients filled up with secretion and developed a degree of atelectasis which had to be relieved promptly or else they would die. They did not stand anoxia well, and when the cardiovascular system collapsed, as it did in association with massive atelectasis, unless something was done the case quickly had a fatal termination. This case following head injury developed respiratory distress, with a sudden rise of temperature and was showing signs of cardiovascular collapse. The diagnosis of atelectasis in the left lower lobe was easily made. The routine with these patients had been to suck them out with a catheter. This procedure had been used for two days in the case of that patient. The catheter was again passed, and a considerable amount of secretion was obtained, but there was no change. He was bronchoscoped, and it was found that his left lower main bronchus was completely filled with a frothy white fluid. That was removed by suction, and the patient, immediately on removal of the bronchoscope, was a good colour, his peripheral circulation was rapidly recovering, and his respiratory rate was countable whilst previously he had been gasping. Six hours later the picture recurred. The bronchoscope was passed again with the same result. Aspiration of accumulated secretion was repeated the following morning. In all it was done five times before this patient finally died. The specimen of his trachea, bronchi, and lungs showed no evidence of any trauma or pneumonia.

Mr. Broek had said that it was possible to collapse a lobe of the lung with blind suction. A friend of his presented a case of atelectasis treated by this method, and he had certainly cured the man of atelectasis on the right side. He was hard put to explain why the patient immediately after treatment had a collapse of the left lower lobe, and that was the danger which was liable to be overlooked. Mucous membrane did not stand up well to the frequent repetition of catheter suction. Eventually small areas of hæmorrhage and reactionary œdema occurred, and in the unit in which he was working the sisters did not like to use the suction catheter frequently, they realized the trauma which could be brought about by such means.

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With regard to the effects of blast, a patient had been severely wounded in Sicily in his right axilla and groin and came to the hospital for plastic treatment. He developed acute appendicitis, and appendicectomy was performed. Twenty hours later he had a respiratory rate of 33, he was cyanosed, and had a temperature which increased within an hour from normal to 103.8. He had no air entry into the right lower lobe, but no other signs of collapse of the lung. A suction catheter was of little use. Therefore bronchoscopy was done. The right lower lobe bronchus was found to be filled with sticky mucus, which was removed by suction. Respiratory rate came down to 20 immediately. Later radiological study of the chest demonstrated an emphysema of the right lung confined to the lower lobe. On forced expiration this lung failed to collapse, and the mediastinum shifted sharply to the left as the left lung collapsed. On this basis a diagnosis of obstructive emphysema was made. Bronchoscopy and lipiodol bronchograms failed to demonstrate any obstruction, but emphysematous areas were filled by the lipiodol. There was still no satisfactory reason for the failure of the lung to collapse, except the possibility of a blast effect, since the man was wounded by H.E. shell.

## ABSTRACTS

### EAR

*The Eustachian Tube : a review of its descriptive, microscopic, topographical and clinical anatomy.* GRANT O. GRAVES and LINDEN F. EDWARDS. (*Arch of Otolaryng.*, May, 1944, No. 5, xxix.)

At the beginning of this detailed study the writers remark that a survey of the Eustachian tube seems timely in view of its importance in relation to some problems of aviation and submarine medicine.

The tube is often assumed to be straight, although the majority of textbooks of anatomy describe an obtuse angle of 160 degrees between the cartilaginous and osseous portions. The writers agree with Spileberg in regarding the course of the tube as an inverted S, as has been confirmed by roentgenograms from living material. All descriptions agree that the pharyngeal orifice is a vertical slit, which becomes triangular when the palate is raised, as during swallowing. The average distance of the orifice from the anterior nasal spine is 7.9 cm., from the posterior edge of the nasal septum 11 mm., from the vault of the nasopharynx and from the posterior end of inferior turbinal 1 cm. in each case. The cartilage of the tube is a triangular sheet, thickest inferiorly and narrowing gradually above to become a hook or crook, bounding the Eustachian canal above and in front. The antero-lateral and inferior walls of the tube are supported by the fibrous structure known as the salpingo-pharyngeal fascia. Various accessory cartilages have been described, related mainly to the floor of the tube. On transverse section the lumen of the tube, triangular at the

pharyngeal end, becomes like an inverted comma as the isthmus is approached, and eventually is reduced to a narrow vertical fissure. The amount of ciliated epithelium lining the tube is variable and it may even extend into the middle ear. A lymphoid layer may be distinguished in the wall of the tube, especially towards the pharyngeal end, where it produces rugae or folds in the mucosa. The isthmus is that point where bone is formed inferior to the tube, the upper boundary being still cartilaginous. The mucosa of the osseous part is a thick muco-periosteum with few mucous glands and no lymphoid tissue. The carotid canal is close to this portion and the bone separating the structures may be deficient. Subtubal air cells are present in 90 per cent of children up to 6 years of age and constitute one route of infection leading to the petrous apex. The action of the muscles related to the tube has been a subject of much discussion. They act upon the palate in the manner indicated by their names tensor palati and levator palati. The tensor palati, by its contractions, dilates the pharyngeal orifice of the tube, it is thus a dilator tubae. According to A. R. Rich, no other muscle has any effect upon the tube. The voluntary acts accompanied by opening of the orifice and lumen are swallowing, yawning, and sneezing. At rest, the tube is never completely closed, a small aperture remaining in the upper part of the lumen. There is a free blood supply to the tube from the tubal branches of the following arteries—ascending palatine, internal maxillary, ascending pharyngeal and middle meningeal. As for the sensory and vasomotor nerve supply, it is derived from the glosso-pharyngeal nerve (sensory), and from the sympathetic plexus on the internal carotid artery (vasomotor). The tensor palati muscle is supplied from the trigeminal nerve and the other muscles from the pharyngeal branch of the vagus nerve.

Studies of the tube by X-ray examination after the injection of iodized oil showed that the obstruction was in the central part of the cartilaginous canal in 90 per cent of the affected tubes, at the isthmus in 7 per cent, and at the pharyngeal end in 3 per cent.

Developmental defects of the tube appear to be rare. Tumours have been reported but are not easy to diagnose. Carcinoma is the most frequent. It causes unilateral deafness, the result of secretory catarrh, and a feeling of fulness or pain in the ear. Metastases in the cervical lymph nodes may appear within three months. Foreign bodies in the tube are usually surgical instruments such as portions of bougie, applicator, etc.

Having thus discussed the anatomy and pathology of the Eustachian tube in the adult, the writers add a note on this structure in the new-born child. The infant's tube is one-half the length of that of the adult, it is straight, and horizontal in direction. The pharyngeal orifice lies close to the vault of the nasopharynx.

As the function of the tube is developed at birth, it is customary on air liners to encourage babies to suck a nipple water bottle so as to induce frequent swallowing. In the descent of sleeper planes, babies as well as adults must be awakened, as the rate of swallowing is only one in every three minutes when the infant is asleep.

Microscopic examination shows a profuse vascularity of the tubal orifice in the infant, also numerous mucous glands, and a subepithelial collection of lymphoid tissue, sometimes as large as to merit the term "tubal tonsil". This

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lies well within the tube and on the médial wall. The mucosa of the osseous portion is ciliated in the infant. A series of excellent microphotographs illustrates this portion of the paper.

The concluding section deals with the importance of the tube in aviation, etc. On the ground and in low-level flying, variations of pressure in the middle ear are readily adjusted by swallowing. An adult swallows once a minute when awake and once in five minutes when asleep. This rate is accelerated while chewing. During ascent in an aeroplane no difficulty is experienced, as the air within the tympanum readily escapes by way of the Eustachian tube. Descents from altitude almost always require some conscious act, such as swallowing, to ventilate the middle ear so as to equalize the barometric pressure. In rapid descent the continuous yell is favoured by dive bombers. During commercial flying, the rate of descent is limited to 500 feet per minute, which causes little or no discomfort to passengers. Only the sleeping air traveller or the drugged wounded soldier will suffer pain in the ears, even during slow descent. When the normal swallowing rate is not consciously accelerated, descents of 1,000 feet per minute may cause pain or even the clinical condition described by McGibbon as *aero-otitis*. Dive bombing descents up to 40,000 feet per minute bring out the complete picture of *aero-otitis*. The distress is not felt in the rarified atmosphere of the higher altitudes but begins at about 20,000 feet. According to McGibbon, the frequency of these aural symptoms in the air forces is 27 per cent. of the air crew personnel. Deafness is the most frequent as well as the most prolonged symptom. It is of the low tone variety (128 to 2048 D.V.) and lasts for four to twenty-eight days. Pain occurs in 61 per cent. of blocked tubes and it may be severe. Usually located in the ear, it may radiate to the cheek and temporal region. Tinnitus occurs in 5 per cent. and vertigo in 3 per cent. of the cases. The signs vary from slight reddening of the drum to intense congestion or even hæmorrhage. Treatment consists in the application of 1 per cent. ephedrine to the Eustachian orifice by means of an applicator. Inflation by the Eustachian catheter may help if the condition is not improving within several days. Should infection occur, incision of the drum may be necessary.

Studies of the ear in caisson workers is far older than aviation. There is no characteristic of the deafness. It has been found that the administration of 80 per cent. helium and 20 per cent. oxygen under positive pressure will prevent symptoms during decompression.

Only recently has there been any investigation of the effect of increased pressure on the ears of submarine crews. They are liable to symptoms identical with those of aviators or caisson workers. Deafness is partial or complete; pain, which may be severe, is almost a constant complaint, and tinnitus is frequent. Symptoms occur in about 10 per cent. of the men but permanent injury is very rare. Deep sea divers are seldom affected as they are lowered to the depths very slowly.

This important and comprehensive paper is illustrated by thirty figures and there is a bibliography of seventy-eight items.

DOUGLAS GUTHRIE.

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*April 1944*

## THE CONSERVATIVE TREATMENT OF CHRONIC SUPPURATIVE OTITIS MEDIA IN ADULTS

By SQUADRON LEADER T. M. BANHAM, R.A.F.V.R. (London)  
with Introduction by AIR COMMODORE E. D. D. DICKSON

PRIOR to the outbreak of present hostilities the presence of an active or quiescent C.S.O.M. constituted a cause for rejection for service with the R.A.F. Since the beginning of the war, very large numbers of the young adult population have been medically examined and accepted for service with the Armed Forces. Some unknown proportion of these young men and women are subsequently found to have a chronic suppurative otitis media, a defect which was not recorded at their initial examination by a National Service Medical Board. Although this proportion may be quite small it leads, owing to the very large numbers of recruits, to there being many such cases in need of treatment. These cases constitute a large part of out-patient attendances at the E.N.T. Centres of the R.A.F.

Apart from the time wasted a C.S.O.M. always provides the individual with an excuse to report sick at any time he wants to avoid duties distasteful to him. What is more important is the time and money expended in training such individuals for trades the duties of which ultimately they are unfit to perform, and who eventually require invaliding, remustering, or regrading. These cases are also unfit for overseas service. An active C.S.O.M. cannot be left untreated, and if presenting polypi, granulations, cholesteatoma, would according to the views held by the examining otologist require a radical or modified radical mastoid operation. Experience has shown that this is an uneconomical procedure as these cases are very often unfit for any further service. They require constant attention, if the initial success of the operation is to be maintained and only in exceptional cases are effectively useful under service conditions.

Conservative treatment is the only alternative if such cases are to remain in the service and be of some use, especially if they have been trained in one of the numerous trades of the R.A.F. If such treatment is to be effective and achieve the desired result, it must be undertaken

by one experienced in and familiar with otoscopic appearances, and skilled in endaural manipulations. The use of aural instruments requires experience, patience, and extreme gentleness. As the patients gain confidence they will allow thorough cleansing without experiencing great discomfort. To delegate such treatment to the untrained, or to the patient himself, need only be mentioned to be condemned. Thorough cleansing of the middle ear and the depth of the meatus of all debris and secretions before the application of any dressing or drug is considered the most important part of the treatment. All manipulations should be under direct visual control, with good illumination of the field of operation. With this end in view Squadron Leader Banham has undertaken the investigation of 200 consecutive unselected cases in order to determine :

- (1) Whether it is possible at the outset to determine if certain cases will respond to treatment within a reasonable length of time, whereas others will fail to do so.
- (2) Whether patients who respond to treatment can be retained in the Service in a useful capacity.

The results of conservative treatment undertaken are adequate evidence of what can be achieved by a properly organized system of treatment and follow up.

## CLINICAL MATERIAL

A series of 200 consecutive cases of chronic suppurative otitis media has been treated by conservative methods. These cases were unselected except that patients who had previously been subjected to any form of radical mastoidectomy were excluded. Even where it was felt at the outset that operation would be required, the conservative method of treatment was tried. The treatment and follow up of these cases has been carried out personally at a Royal Air Force Hospital.

The otoscopic appearances of 200 consecutive cases of past middle-ear suppuration, which were inactive when first examined, have been recorded. These cases were patients who, having been found to be deaf or to have an abnormal tympanic membrane on routine examination, were referred to this Department for advice as to the cause of their deafness, or to determine their fitness for overseas service. Their aural infection had resolved spontaneously or had previously responded satisfactorily to treatment. Patients who had been subjected to any form of mastoidectomy were not included in this series.

### Methods of Treatment used in present Series of 200 Cases of Chronic Suppurative Otitis Media

Reference to the results of other workers treating cases of chronic suppurative otitis media shows that the highest percentage of cures is claimed by those using dry methods, such as the insufflation of boracic

## Treatment of Chronic Suppurative Otitis Media

powder with various percentages of iodine. It was decided, therefore, that this type of treatment should be used as a basis for the present investigation, whenever practicable.

It was realized at the outset that the most important part of any treatment of chronic suppurative otitis media is thorough cleaning of the ear. This has been previously recorded by other workers, notably H. Donnell (1), who stated: "I believe that most chronically infected ears will heal if kept clean."

The following powders have been used in the treatment of these cases of chronic suppurative otitis media:

*Boracic powder with 1 per cent. iodine.* The first powder used was 1 part precipitated iodine, ground in a mortar with 99 parts of boracic acid powder, as used by M. D. Lederman (2).

*Boracic and Sulphapyridine powder with 1 per cent. iodine.* The second powder was a mixture of 1 part precipitated iodine, 49.5 parts boracic acid powder, and 49.5 parts sulphapyridine powder. The theoretical advantage of this compound is that the iodine is rapidly given off after the powder is insufflated into the ear, and the addition of sulphapyridine prolongs the antibacterial effect of the powder. The disadvantage of undiluted sulphapyridine powder is that, owing to its insolubility in water, it tends to remain in the auditory meatus as a cement-like mass when the discharge is only very slight; this did not occur when it was diluted with boracic acid powder.

*Boracic and Sulphathiazole powder.* The third powder consisted of 50 parts sulphathiazole mixed with 50 parts boracic powder. Sulphathiazole, as compared with sulphapyridine, has the theoretical advantage that it is bacteriostatic to a larger range of organisms and has a greater effect on *Staphylococcus aureus*, as shown by G. Rake and C. M. McKee (3). A further advantage is that sulphathiazole is more soluble in water than sulphapyridine. I first began using this powder for the treatment of cases of chronic otitis externa, and found it most satisfactory. As I consider one of the main objects in the treatment of chronic suppurative otitis media to be the control of the secondary invading organisms from the external meatus, the use of sulphathiazole was therefore logically extended to cases of chronic middle-ear suppuration also.

### Method of Treatment

The meatus is thoroughly cleaned, under direct vision, using wisps of sterile wool wound on to a Jobson Horne probe. Any aural polypi or granulations, which are revealed by cleansing, are treated at the first attendance. Polypi are removed with crocodile forceps, after anæsthetizing the ear with cocaine hydrochloride 5 per cent., to which a few drops of adrenalin hydrochloride 1-1,000 (to cause vaso-constriction) have been added. This solution is applied on sterile cotton wool, which is packed



in the depths of the meatus for about ten minutes. The polyp is then seized with the spring crocodile forceps, under direct vision, and pulled out very gently. The base of the polyp, and any flat granulations are cauterized with trichloroacetic acid, which is applied on a very small wisp of cotton wool wound on to the Jobson Horne probe. The middle ear is now emptied by Eustachian inflation, either by Valsalva's method or by catheterization. In some cases the middle ear is best emptied by suction applied through a fine cannula passed through the perforation. Suction is obtained from a Sprengel's water pump, using a fine straightened Eustachian catheter as a cannula. Suction will sometimes reveal small polypi, which may be drawn through the perforation, so that they can be seized by crocodile forceps. The ear is now thoroughly dried, powder insufflated so as to enter the middle ear and fill the depths of the meatus, and gauze wick, wrung out in Flavine and S.V.R. 1-2,000 solution, ether methylated solution, or Protargol 10 per cent. solution is left in the meatus. This treatment is continued as frequently as is required; twice or once a day, every 2 or 3 days, or once a week. The patient is instructed to remove the pack after 48 hours, or before if it becomes soaked through to the outside.

If, when the discharge has ceased, dried powder remains in the meatus, it may be removed by gently syringing the ear with warm saline, and then thoroughly drying the ear with sterile cotton wool wisps. During the course of treatment, any naso-pharyngeal source of infection must be eradicated.

When these chronic cases have become dry, it is found that, if a relapse occurs following a naso-pharyngeal infection or entry of water into the middle ear, they can be quickly healed again, in many instances with one or two treatments only, if the treatment is instituted within a few days of the reappearance of the otorrhœa. The most important part of this treatment is the thorough cleaning of the meatus and middle ear, and the accurate application of the powder. It must be pointed out that it is considered that the best results can only be obtained if *all endaural manipulations are carried out personally*, and not delegated even to a nurse, unless she has been especially trained. The use of aural instruments requires experience, patience, and extreme gentleness. As the patients gain confidence, they will allow thorough cleaning, including touching the tympanic membrane with sterile wool swabs, and the passing of a cannula through a perforation without experiencing any great discomfort.

If, for any reason, personal attention cannot be given, syringing is considered to be the surest and safest method of cleaning the meatus. *Blind cleaning with aural instruments must never be allowed.*

The three types of powder, previously described, have been used. Any case which did not respond, in a reasonable length of time, to one

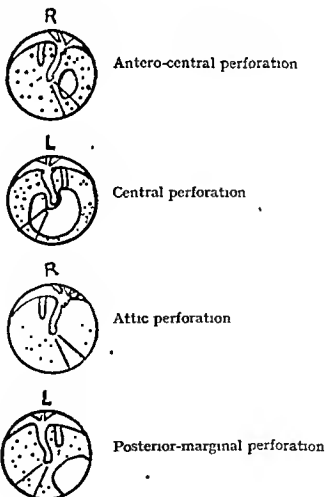
# Treatment of Chronic Suppurative Otitis Media

type of powder was treated with one or both of the other types. It was found that those cases which did not respond to the initial type of powder used were not improved when either of the other two were substituted. My impression is that the powder containing sulphathiazole gives the quickest results and is the least irritating. No statistical evidence can be given to substantiate this impression as equal, unselected groups of cases were not treated with each type of powder.

## Definition of Terms

*Perforation of tympanic membrane.* By custom, the term "central" perforation has come to mean any perforation affecting the pars tensa of the tympanic membrane and in which the annulus tympanicus is not involved. During this investigation, "central" perforations, as a group, have been subdivided with the object of estimating the prognosis according to the site of this type of perforation occurring during middle-ear infections. The term "central" perforation is, therefore, restricted to a perforation in the centre of the tympanic membrane. Perforations in front of, or behind the handle of the malleus which do not involve the annulus tympanicus are termed antero-central and postero-central respectively.

The terms "marginal" and "attic" perforations are employed in the customary senses to signify a perforation involving the annulus tympanicus and Shrapnell's membrane respectively.



## End Result of Treatment

**"Dry Ear."** A satisfactory dry ear means that not only does the patient report that there is no discharge, but on examination the middle ear is seen to be free from discharge with a healthy glistening mucous membrane, and a dry whistling sound is obtained when the Eustachian tube is inflated by Valsalva's method. This result cannot be claimed as a cure in the sense that the discharge has ceased for ever. Any patient with a perforation of the tympanic membrane is liable to a recurrence of otorrhœa if a naso-pharyngeal infection is contracted or moisture is allowed to enter the middle ear.

**"Quiescent Ear."** I have classified as quiescent those ears which, on examination, show a moist perforation or some discharge in the depths of the meatus after seven or more days without treatment. The patients say that their ears are dry or that "some soft wax has come out".

**"Unchanged Ears."** Patients are said to be unaffected by treatment when otorrhœa continues.

## Statistical Summary of 200 Cases treated personally

### (1) Clinical result of conservative treatment.

Dry ears .. .. .	165	82.5%	
Quiescent ears .. .. .	17	8.5%	
Unchanged ears .. .. .	18	9.0%	
Hearing improved by treatment	84	40%	(In 4 cases the hearing was recorded as normal at the initial examination.)
Tympanic membrane healed ..	14	7%	

### (2) Table to show the relationship of duration of symptoms to the result of conservative treatment.

Duration of otorrhœa.	Number of cases.	Dry ears.	Quiescent ears.	Unchanged.
Under 6 weeks ..	8	8 100%	—	—
6 weeks to 1 year ..	28	26 93%	1 3.5%	1 3.5%
1 year to 5 years ..	31	23 74%	4 13%	4 13%
Over 5 years ..	133	108 81%	12 9%	13 10%
Totals .. .. .	200	165	17	18

# Treatment of Chronic Suppurative Otitis Media

## (3) Result of conservative treatment in cases classified according to their auditory acuity at the outset of treatment of infected ear.

Hearing	Number	Dry ears	Quiescent ears	Unchanged
Forced whisper (F W) not heard	63	40 63%	9 14%	14 23%
F W 0-2 feet	53	45 85%	5 9%	3 6%
F W 2-5 feet	45	44 98%	1 2%	Nil
F W 5-10 feet	18	15 83%	2 11%	1 6%
F W Over 10 feet	19	19 100%	Nil	Nil
Hearing not recorded	2	2		
Totals	200	165	17	18

## (4) Result of treatment in cases classified according to otoscopic appearances.

Site of perforation	Number of cases	Dry ears	Quiescent ears	Unchanged
Postero-central perforation	89 44.5%	84 94%	3 3.5%	2 2.5%
Antero-central perforation	30 15%	27 90%	2 6%	1 4%
Large central perforation	14 7%	13 93%	Nil	1 7%
Attic perforation	23 11.5%	19 83%	1 4%	3 13%
Marginal perforation	41 20.5%	20 49%	11 26%	10 25%
Site of perforation unknown	3 1.5%	2	Nil	1
Totals	200	165	17	18

Central perforations with granulations	52 26%	43 83%	5 10%	4 7%
Central perforations without granulations	81 40.5%	81 100%	Nil	Nil
All cases showing granulations	91 45.5%	64 70%	15 16%	12 14%
Cases with definite cholesteatoma which could not be entirely removed through the external meatus	5 2.5%	Nil	Nil	5 100%

# T. M. Banham

## (5) *Duration of treatment.*

Duration.	Number.	Dry ears.	Quiescent ears.	Unchanged.*
Less than 1 week ..	20	20 100%	Nil.	Nil.
1-2 weeks .. ..	75	74 98%	Nil.	1 2%
2-4 weeks .. ..	50	44 88%	4 8%	2 4%
1-2 months .. ..	24	18 75%	4 17%	2 8%
2-6 months .. ..	24	8 33%	9 37%	7 30%
6-12 months .. ..	5	1 20%	Nil.	4 80%
Over 12 months ..	2	Nil.	Nil.	2 100%
Totals .. ..	200	165	17	18

\* Treatment discontinued either owing to invaliding from the Service or posting from the area served by this Department.

(6) Labyrinthine symptoms were noted in one case. No cases of intracranial complications occurred in this series.

(7) *Recurrence rate.* The 165 cases of chronic suppurative otitis media who responded satisfactorily to conservative treatment have been kept under observation for periods varying according to the exigencies of the Service. Unfortunately, a number have been observed for only a short period, but a substantial number (sufficient to give valid results) have been followed up for six months or considerably longer.

Last attendance <i>less than one month</i> from the commencement of treatment.	23 cases. No recurrence of otorrhœa. All dry at last attendance.
Last attendance <i>one to two months</i> from the commencement of treatment.	20 cases. No recurrence of otorrhœa. All dry at last attendance.
Last attendance <i>two to three months</i> from the commencement of treatment.	21 cases. No recurrence of otorrhœa. All dry at last attendance.
Last attendance <i>three to four months</i> from the commencement of treatment.	20 cases. No recurrence of otorrhœa. All dry at last attendance.
Last attendance <i>four to six months</i> from the commencement of treatment.	32 cases. 2 cases had a temporary recurrence of otorrhœa. All dry at last attendance.
Last attendance <i>six to twelve months</i> from the commencement of treatment.	38 cases. 9 cases had had a recurrence of discharge. 35 cases had dry ears at last attendance. 3 cases did not respond satisfactorily to a second course of treatment.
Last attendance <i>over twelve months</i> from the commencement of treatment.	11 cases. 3 cases had had a recurrence. All dry at last attendance.

# Treatment of Chronic Suppurative Otitis Media

200 cases of chronic suppurative otitis media, which were inactive when first seen, classified according to the site of the perforation in the tympanic membrane.

Dry antero central perforation .

19 medium perforations (9.5%)  
7 small perforations (3.5%)  
3 large perforations (1.5%)



Dry central perforations .

24 large perforations (12%)  
3 medium perforations (1.5%)



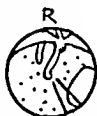
Dry postero-central perforations .

62 medium perforations (31%)  
10 small perforations (5%)  
12 large perforations (6%)



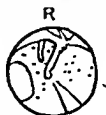
Anterior marginal perforations

Nil



Posterior marginal perforations

7 medium perforations (3.5%)  
1 large perforation (0.5%)



Attic perforations

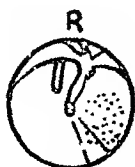
10 medium perforations (5%)



140  
cases  
(70%)

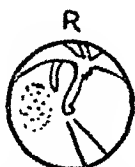
Healed antero-central perforations :

6 medium perforations (3%)  
1 small perforation (0.5%)



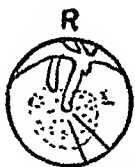
Healed postero-central perforations :

27 medium perforations (13.5%)  
1 large perforation (0.5%)  
4 small perforations (2%)



Healed central perforations :

3 medium perforations (1.5%)



42  
cases  
(21%)

## DISCUSSION OF STATISTICAL SUMMARY

*200 cases of chronic suppurative otitis media treated personally by conservative dry treatment.*

The 200 cases were unselected ; even where it was felt at the onset that operation would be required, the conservative methods of treatment previously described were used.

TABLE 1 shows the clinical result of treatment of these cases.

TABLE 2 shows the end result of cases grouped according to the length of time since the commencement of the otorrhœa. All the 8 cases with a history of less than 6 weeks' otorrhœa responded to conservative treatment but the number of cases is too small to be of statistical value.

TABLE 3 shows the result of conservative treatment on these cases, grouped according to their auditory acuity at the commencement of treatment.

Nineteen patients could hear a forced whisper at over 10 feet, and these all responded satisfactorily to treatment. Sixty-three patients could not hear a forced whisper at all, and only 63 per cent. of these resulted in a dry ear. (Cases of attic suppuration are an exception, as they often have good hearing whether the prognosis is favourable or not.)

TABLE 4 records the results of conservative treatment classified according to the otoscopic appearance.

*Central Perforations.* Central perforations (perforations of the pars tensa, which do not involve the fibro-cartilaginous ring surrounding

# Treatment of Chronic Suppurative Otitis Media

the membrane) are found in over 66 per cent of cases. Patients with this type of perforation respond most satisfactorily to conservative treatment. 81 out of the 200 patients were found to have a *central perforation without granulation*, and of these, all, without exception, responded satisfactorily to conservative treatment. The significance of this observation as regards prognosis does not appear to have been recorded previously. In this series there was no significant difference in the response to treatment of antero central or postero central perforations, dry ears being obtained in 90 and 94 per cent of cases respectively.

*Attic perforations* 23 cases of attic disease were treated, and 83 per cent of these responded satisfactorily to treatment. These cases have, in most instances, very localized disease in one of three main positions, in the anterior or posterior pouches of Tröltzsch or in Prussak's pouch. These sites of tympanic membrane perforation may be described as anterior, posterior and central attic perforations. In this series of 23 cases, there were 6 anterior, 11 posterior and 6 central perforations. The response to treatment by conservative methods appears to me to depend on two main factors.

(1) *The size of the perforation* I have found that if the perforation is sufficiently large to admit a probe with a small wisp of cotton wool, the diseased pouch can be cleaned thoroughly and the prognosis is good. Cases with a very small perforation are much more difficult to treat conservatively.

(2) *The presence of extensive cholesteatoma* which cannot be removed through the perforation. No case will heal until all cholesteatomatous material has been removed and it can only be removed if it is still confined to the diseased pouch and has not extended further into the attic or mastoid antrum.

*Marginal perforations* In this series of cases the results of treatment in cases showing a marginal perforation are strikingly worse than those with other types of perforation, as only 49 per cent resulted in a dry ear.

These cases can be further subdivided into anterior and posterior marginal perforations.

Site of perforation	Total cases	Dry ear	Quiescent ear	Unchanged
Anterior marginal perforation	11	6 (55%)	1	4
Posterior marginal perforation	30	14 (47%)	10	6

In this series, both anterior and posterior marginal perforations appear to respond equally poorly to conservative treatment, and this appears to confirm the statement that a marginal perforation is usually associated with bone necrosis. P. D. Kerrison (4)



# T. M. Banham

*Granulations.* Nearly half of the cases treated (48 per cent.) showed either granulations or cholesteatoma. N. Asherson (5) has stated that "Every case of cholesteatoma, moist granulations or aural polypi requires prompt operation (the radical mastoid)." If this dictum had been adhered to, 96 cases would have required the radical mastoidectomy, in addition to those cases without granulations which did not respond to conservative treatment. Of the 200 patients treated conservatively I consider that a minimum of 18 (those unchanged by treatment) and a maximum of 38 (those unchanged, quiescent or relapsing after treatment) required some form of operative treatment.

The following Table is an attempt to classify the granulomatous tissue encountered in this series of cases of chronic middle-ear suppuration, according to its type and origin, and comments on each type follows.

	Total.		Dry ear.		Quiescent ear.		Unchanged.	
(a) Unhealthy middle-ear mucosa seen through perforation .. ..	12	13%	11	91.5%	1	8.5%	—	
(b) Flat granulations on tympanic membrane .. ..	39	43%	31	79.5%	2	5.5%	6	15%
(c) Granulations situated on posterior meatal wall ..	13	13.5%	10	77%	1	8%	2	15%
(d) Polyps arising from the tympanic membrane, the malleus or the tympanic ring .. ..	16	18%	10	66.5%	5	31%	1	6.5%
(e) Polyps arising from the middle ear ..	6	7%	—		4	67%	2	33%
(f) Granulations situated on the inner tympanic wall ..	5	5.5%	2	40%	2	40%	1	20%

Although the numbers of cases in each group are too small for definite conclusions to be drawn, the following deductions would seem to be warranted.

(a) The first group probably represents a mistaken assessment of the real nature of the middle-ear mucosa. When this is unhealthy and cedematous, its appearance may easily be mistaken for granulation tissue, but the actual condition can be seen after one or two treatments, as the swollen mucosa quickly returns to normal.

(b) The largest group (39 cases) is composed of cases showing flat granulations on the tympanic membrane. Nearly 80 per cent. of these

## Treatment of Chronic Suppurative Otitis Media

cases resolved satisfactorily with conservative treatment, including cauterization of the granulation tissue. In these cases the prognosis is good if the plaque of granulations is small, but where it has extended over about a quarter of the surface of the membrane, the response to treatment is disappointing.

(c) Granulations on the meatal wall in the depths of the meatus probably result from a small superficial ulcer caused by the purulent discharge. This condition has been previously described by A. Tumarkin (6). 77 per cent. of this group responded satisfactorily to treatment, and I think this is conclusive evidence that the granulations have not arisen from the diseased bone.

(d) Polyps arising from the tympanic membrane, the malleus or the tympanic ring were encountered in 16 cases, and 10 of these resulted in a dry ear. These cases have quite a good prognosis, as the site of origin of the polyp can be kept under observation and treated by cauterization until healed. Tumarkin (7) has described the good results that follow the removal of the "acute benign aural polyp".

(e) and (f) I consider that the presence of granulation tissue on the inner tympanic wall indicates that the prognosis with conservative treatment is poor. At the initial examination of the tympanic membrane, it is difficult to distinguish between this condition and that recorded in group (a), but after one or two treatments an œdematous mucosa will have subsided, whereas granulations remain. These tympanic granulations and group (e), which are polypi arising from the tympanic cavity, are evidence of diseased bone, and are an indication that surgical treatment will almost certainly be necessary.

Tympanic granulations, therefore, indicate that the prognosis is poor if conservative treatment is used, whereas granulations arising from the tympanic membrane or meatus, especially if the area of granulations is small, indicates a relatively good prognosis.

*Cholesteatoma.* The presence of cholesteatoma which cannot be entirely removed through the perforation in the tympanic membrane prevents the ear from healing. In large attic perforations, well localized small masses of cholesteatoma can sometimes be entirely removed with small cotton wool swabs soaked in ether methylated solution, and these cases will then respond to conservative treatment. If, however, the cholesteatoma extends from the attic pouch through the aditus to the mastoid antrum, its complete removal by surgical means is necessary before the ear can be cured. If the perforation is small, the presence of cholesteatoma can be diagnosed by the fact that the otorrhœa remains offensive, with a peculiar "mousy" odour in spite of daily conservative methods of treatment, and X-ray examination of the mastoid may show an area of erosion. These cases require operation as soon as the presence

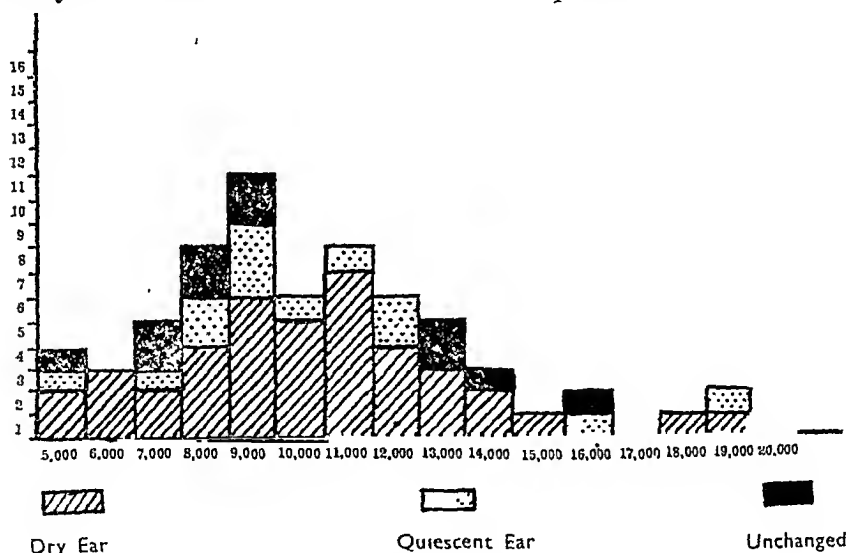
# T. M. Banham

I think, therefore, that the estimation of the blood sedimentation rate at the outset of treatment is helpful in estimating the ultimate prognosis, as a high reading is evidence that the case is less likely to respond to treatment than if the reading is normal.

A high reading might be expected in all cases with bone necrosis, as A. C. Rees Walton (8) has shown that cases of osteomyelitis have a high blood sedimentation rate. Cases of chronic suppuration otitis media, however, with definite bone infection and cholesteatoma formation, which has been proved at operation, can show a reading of 3 mm. in 1 hour. This, however, is not an exact analogy as this is an osteitis and not osteomyelitis.

## Blood Leucocyte Count

The following chart represents the three end results (dry, quiescent or discharging ear) of conservative treatment, correlated with the initial leucocyte count. These 66 cases were all in-patients.



## Total W.B.C. per c.mm.

This appears to show that the estimation of the total leucocyte count is of no assistance in estimating the prognosis of the case. Both ends of the scale, varying from a total count of 5,000 per c.mm. to 20,000 per c.mm. showed cases with all three end results. Subdivided these cases give the following results :

Leucocyte count.	Number.	No. and % dry.	
5-7,000	12	7	58%
8-10,000	25	15	60%
11-13,000	19	14	74%
Over 14,000	10	5	50%

No trend is apparent therefore.

# Treatment of Chronic Suppurative Otitis Media

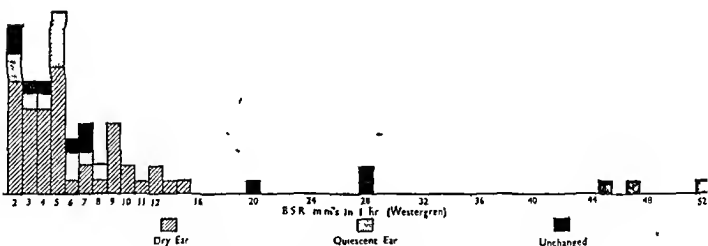
*Dry attic perforations* were found in 5 per cent. of cases (the incidence being 11.5 per cent. in the treated series).

These findings show that, from the observation of the position of the perforation in the tympanic membrane, in cases which have responded to previous treatment or healed spontaneously, those with a central perforation have much the best prognosis, and those with a marginal perforation have the worst prognosis. Cases showing an attic perforation have a better prognosis than marginal perforations.

These facts confirm the previously recorded results of conservative treatment (Table 4).

## Erythrocyte Sedimentation Rate of the Blood

The following chart represents the three end-results (dry, quiescent or discharging ears) of conservative treatment, charted according to their blood sedimentation rate at the outset of treatment. These 69 cases were not entirely unselected as this investigation was only performed on patients admitted to hospital for treatment. This includes most of the cases which were considered to have a poor prognosis and therefore required more intensive treatment.



These figures give the following results :

BSR	Number.	No and % dry.	
2-3	20	14	70%
4-5	21	15	71%
6-14	22	15	68%
Over 20	6	0	0%

This shows that there is no significant difference until the 20+ group is reached.

of the cholesteatoma has been definitely diagnosed. Five cases in the present series fall into this group, and all required surgical treatment.

*Duration of treatment.* Table 5 shows the results of conservative treatment classified according to the length of time of treatment. This seems to show that treatment can be continued for at least two months with a good expectation of the ear ultimately healing. After this the chances become much less. Of the 24 cases treated for 2 to 6 months, only 8 (33 per cent.) resolved satisfactorily. Only 1 case out of 5 treated for 6 to 12 months healed, and neither of the two cases treated for over 12 months responded to conservative treatment. Attic suppuration may resolve after prolonged treatment and 6 of the 8 cases which became dry after 2-6 months were of this type. Any case showing a central or marginal perforation which has not responded to rigorous conservative treatment in 2 or 3 months should be submitted to operative treatment.

*Recurrence rate.* Table 7, with notes, is self-explanatory as regards the results of treatment. It is evident that, with an open perforation, in cases kept under observation for a considerable period, a small proportion of recurrence of otorrhœa is to be expected. In most instances this responds rapidly to further treatment. In order to obviate these recurrences as far as possible, patients are warned that upper respiratory infections or the entry of water into the ear, as in bathing, may result in further discharge. In this eventuality they are advised to seek further treatment without delay.

#### *200 cases of Inactive Middle-ear Infection (Untreated)*

These cases are patients who, having been found to be deaf or to have an abnormal tympanic membrane on routine examination, were referred to me either for advice as to the cause of their deafness, or to determine their fitness for overseas service.

No treatment was carried out, as no active infection was present in these cases.

These cases, having resolved either with or without treatment, demonstrate the most favourable sites of perforation of the tympanic membrane.

The two largest groups of cases are those showing medium sized dry postero-central perforations (31 per cent.) and healed medium sized postero-central perforations (13.5 per cent.).

Dry or healed postero-central perforations of *all* sizes comprise 58 per cent. of this series.

Dry or healed *central perforations* of all positions and sizes comprise 91 per cent. of cases. (In my series of treated cases central perforations were seen in only 66.5 per cent. of cases.)

Dry *marginal perforations* were seen in only 4 per cent. of these cases, and none of these was healed (the incidence of this site of perforation in my treated series was 20.5 per cent.)

# Treatment of Chronic Suppurative Otitis Media

## Additional Hearing Tests

Rinne's test was recorded in 102 cases. In 99 cases the hearing by bone conduction was longer than by air conduction (Rinne negative). In 3 cases the hearing by air conduction was longer than by bone conduction (Rinne positive).

Hearing tests with C64 and C4096 tuning forks were performed on 96 cases

C64 not heard—C4096 heard	54 cases
Both heard	26 cases
Neither heard	16 cases

These results show that the hearing defect is in the conduction of sounds to the middle-ear in the great majority of cases of chronic suppurative otitis media. The fact that C4096 can be heard in 54 cases when C64 is not heard supports the theory that high notes are conducted directly to the inner ear and are not dependent on the ossicular chain. In no case was C4096 not heard when C64 was heard.

Having discussed the results of treatment of chronic suppurative otitis media, an attempt can be made to answer the following questions:

(1) *Can it be determined at the outset that certain cases will respond to conservative treatment within a reasonable length of time, whereas others will fail to do so?*

I consider that all cases of chronic suppurative otitis media with a central perforation of the tympanic membrane and no granulations will respond to conservative treatment (40 per cent of my cases can be grouped under this heading). If frequent relapses occur, these cases require only a cortical mastoidectomy to obtain a dry ear.

No certain prognosis can be given for the remaining 60 per cent of the cases, but if the history and various physical signs are considered, a fairly accurate prognosis can be given if the following points are considered:

(a) *Duration of otorrhœa*. If this is less than 12 months between 90 per cent and 100 per cent of cases can be expected to respond to treatment.

(b) *Auditory acuity*. Excluding cases of attic disease, it can be stated that if the hearing is good at the outset of treatment the prognosis is good.

(c) *Otoscopic appearance*. Central perforations with small areas of granulations on the surface of the tympanic membrane, or small polypi which are attached to the malleus or the membrane have a good prognosis. Over 80 per cent of all central perforations with granulations can be expected to result in a dry ear, but the types that respond poorly to treatment are those showing extensive sessile granulations or a polyp whose pedicle passes through the perforation.

Over 80 per cent. of attic perforations will become dry. The prognosis is good if the perforation is sufficiently large to allow thorough cleaning of the cavity, but does not extend to the extreme periphery of the membrane. Very small attic perforations or extensive attic perforations with obvious erosion of the surrounding bone have a poor prognosis.

Both anterior and posterior marginal perforations have a poor prognosis, and only about 50 per cent. can be expected to result in a dry ear.

(d) *Length of treatment.* If the ear is not dry after 2 months of continuous and thorough treatment, the prognosis is poor. Less than one-third of those cases which were treated for more than 8 weeks finally healed. If the discharge continues profusely and remains offensive after three or four treatments, operative treatment is indicated—further trial of conservative treatment being dangerous. The smell of a ribbon gauze drain, removed from the meatus after a few hours in a case of chronic otitis media with cholesteatoma is quite characteristic.

(2) *Can patients who respond to treatment be retained in the Service in a useful capacity?*

Patients who obtain a *dry ear and a healed perforation* are found to be fit for full ground duty in the Royal Air Force. Flying personnel can be returned to some form of non-operational flying. Patients who obtain a *dry ear with an open perforation* can be retained in the service on full ground duties but are considered to be unfit for service overseas. They are liable to a recurrence of otorrhoea if a naso-pharyngeal infection is contracted or moisture is allowed to enter the middle ear and they are retained in this country so that they have easy access to specialist attention at all times.

The only additional restriction placed on patients who have a scarred middle ear is that they are warned not to expose themselves unnecessarily to excessive noise such as firing on the rifle range. They are all instructed to report *at once* if they have any recurrence of discharge.

Patients who obtain a *quiescent ear* require treatment every one to four weeks and must be kept under regular observation. Many of these can continue to give useful service if posted to the vicinity of an Ear, Nose and Throat Centre where they can obtain treatment without undue loss of working time.

All the patients whose ears are unchanged by treatment require operative treatment. This is only carried out in the R.A.F. if they are valuable trained individuals. The remainder are invalided from the Service for operative treatment to be carried out in a civilian hospital.

### Summary

(1) The method of treatment of chronic suppurative otitis media as used at one Ear, Nose and Throat Centre is described in detail. The

# Treatment of Chronic Suppurative Otitis Media

essentials of treatment are thorough and frequent cleaning, insufflation of powder such as boracic acid and sulphathiazole, and promotion of continuous drainage by leaving a ribbon gauze wick soaked in flavine and spirit in the meatus. Treatment is performed as often as the extent of the discharge necessitates.

(2) Two hundred cases of chronic suppurative otitis media treated at one R A F Centre are described in detail, with special reference to the otoscopic appearances.

(3) The otoscopic appearances of 200 cases of past middle-ear infection are described to demonstrate the types which can be expected to respond to treatment or to heal spontaneously and remain with a dry middle-ear.

(4) The 400 personally observed cases are compared, and the prognosis of various types of middle ear infection are described.

The results of treatment of the cases of active chronic suppurative otitis media show that over 80 per cent responded satisfactorily to non operative treatment.

Cases showing a central perforation of the tympanic membrane without granulations respond most satisfactorily to treatment, 100 per cent resulting in a dry ear.

Cases with granulations have a much better prognosis than has been described by other workers. Cases with marginal perforations have the least favourable prognosis. The relationship of the length of the history and the initial auditory acuity to the final response to treatment is discussed. The estimation of the total leucocyte count is found to be valueless, but the blood sedimentation rate is of some use in estimating the prognosis of these cases.

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# GASTRO-ENTERITIS AND MASTOIDITIS IN INFANTS

By B. COHEN (London)

SINCE the first observations, chiefly post-mortem, were made between 1870 and the end of the 19th century, a considerable literature has grown up dealing with latent otitis media in infants, and especially in its possible relationship to alimentary disorders, and no little controversy has occurred with the presentation of conflicting results by different authors, mainly American. There are relatively few references in British literature on this subject. Great interest was aroused among physicians and surgeons alike when the first results of operative treatment on the ear were published, but the first enthusiasms became less pronounced as the field of experience widened and less favourable impressions were reported. For an assessment of the present position it might therefore be advisable to review some of the more important references on the subject. It will be followed by an account of the author's experience with these cases during a three year period, and finally such conclusions as he has reached.

Among the first to note the possibility of the middle ear being a locus of infection, seldom diagnosed clinically, Wreden (1) in 1868 observed the common finding of pus in the middle-ear cleft in fatal cases of broncho-pneumonia, and was of the opinion that the otitis was secondary to the pulmonary infection. Rasch (2) confirmed these findings in 42 out of 93 deaths from broncho-pneumonia, and Ponfick (3) reported such findings in 10 of 11 consecutive deaths from the same cause. Hartman (4) was the first, however, to call attention to the presence of a middle-ear infection in nutritional disorders of infants, and improvement in the latter condition when the middle ear or mastoid was treated. Goeppert (5) was of the opinion that the otitis was probably secondary to the gastro-intestinal disorder, and noted that ear complications were common in this condition, infected middle ears being present in 12 per cent. of his series. Kistler (6) from the Virchow Pathological Institute, frequently found pus in the mastoids of infants at autopsy, but the clinical states are not indicated. As a result of these and other publications, it was common practice in Germany at that time for myringotomies to be performed on a large proportion of infants with gastro-intestinal symptoms, regardless however of the presence or otherwise of changes on the drum head. It was only natural that the results were inconclusive, confusing and disappointing, and the procedure was on the whole abandoned.

Fresh interest, however, was created by Renaud (7) who published his observations in 1921. He instanced 70 consecutive deaths in which

## Gastro-Enteritis and Mastoiditis in Infants

extensive suppuration in the mastoid and labyrinth were discovered at post-mortem, there being bilateral involvement in a large number. In 30 cases aural infection had been diagnosed before death, and in 40, it had been overlooked. Apart from the terminal changes in the brain and its smaller vessels, the only pathological lesion which could reasonably account for the gastro intestinal intoxication was the presence of pus in the mastoid. Extending these observations clinically, he performed paracenteses in 36 cases with a 38 per cent recovery rate, and mastoidectomy in 10 cases with a 10 per cent recovery. His low recovery rate especially following mastoid operation he attributed to the late stage of interference. With the publication of these findings, fresh impetus was given for further observations, these were made chiefly in America.

M L Floyd (8) reported on 26 cases of this type of middle-ear infection seen and treated over a period of eighteen months, but no statistical information other than this was given. McKim Marriott (9) diagnosed and operated on 20 cases, and found streptococcal pus in all. A constant clinical sign in his series was the sagging of the inner part of the meatal roof, and he suggested that blockage of the aditus and antrum, either because of the narrowness of the passage, or the infolding of the embryonic mucosa, may lead to a residual mastoiditis with an apparently normal drum. It is possible that the streptococcal toxin, he proceeds, exerts a specific action on the capillaries of the body in general, and on the alimentary tract in particular, which results in the loss of fluid so characteristic of the disease. Dean (10) was of the opinion that paranasal infection commonly co existed with the otitis, but neither this nor Floyd's theory of the streptococcal toxin have been confirmed. In an interesting paper on the subject, Lyman (11) reported on 43 cases in which mastoidectomy had been performed with positive findings in the bone. Nine of the cases died. He concluded that the ultimate decision rested with the surgeon whether mastoidectomy should be performed. "If the child's general condition is good myringotomy may be done as a first step, if the condition is otherwise, or there is no response to myringotomy, the mastoids should be cleared at once." The difficulties of otoscopic examination are stressed. He noted that owing to the proximity of the malleus to the postero superior meatal wall, bulging of the upper quadrant of the drum will closely simulate mural sagging. "Mastoid infection occurs when the embryonal tissue in the aditus and antrum is involved and the absence of this tissue in the greater part of the tympanum accounts for the success, in some cases following myringotomy." In his series, cases tended to occur in minor epidemics, while at other times only sporadic cases were seen. The predominant organism was a streptococcus. Alden and Lyman (12) published 15 cases of mastoidectomy with seven deaths.

Asherson (13) refers to the possible association of gastro intestinal

he concluded that 14,000 deaths were preventable. It seems unjustifiable however, to refer the findings in 72 cases to such a large figure as returned by the Registrar-General.

Summarizing, at this juncture, the problems for discussion would appear to be

(1) What is the relationship between the two conditions? coincidental or has the otitis an ætiological significance?

(2) In what proportion of cases does the association occur, and what factors influence the incidence?

I think it is fairly safe to state, on the evidence quoted above, that middle-ear infections occur with varying frequency in the alimentary disorders of infants, the variants probably being seasonal and geographical, much in the way that upper respiratory tract infections vary. It is abundantly clear, however, that the middle ear cannot be inculpatated in the vast majority of such gastro-intestinal disorders, but when otitis media does occur the prognosis is aggravated considerably. Whether the otitis is secondary to the alimentary disorder or vice versa is still a matter of dispute, but it may well be that the importance attached to the solution of this problem has been overstressed. There is still room in medical practice for empiricism and pending an exact and final solution, it would be rash to ignore a therapeutic procedure which will lessen, to some extent, the mortality of this serious disease.

My own experience of such cases is illustrated below. The records cover the period from May, 1941, to August, 1944, during which 264 cases of diarrhoea and vomiting were treated at the Queen Elizabeth Hospital for Children. Some occurred after admission to hospital, the majority were admitted with the complaint. A proviso before admission was the presence of a moderate or severe degree of dehydration. Grouped on an ætiological basis the cases presented the following proportions:

(1) Pulmonary Infections	.. .. .	19%
(2) Middle-ear Infections (including mastoid)		25%
(3) Urinary Infections	.. .. .	2%
(4) Other Conditions	.. . . .	54%

Among the last group are included summer diarrhoea, prematurity, icterus gravis, mental deficiency, pyloric stenosis, ulcerative enteritis, etc.

For the purpose of comparison four periods were examined, viz.:

*Number of Cases treated*

Groups.	May-Dec. 1941.	1942.	1943.	Jan.-Aug. 1944.
Pulmonary .. ..	6	29	19	14
Middle Ear .. ..	9	13	15	13
Urinary .. ..	0	3	3	0
Others .. ..	48	57	23	22
Total number of cases	63	102	60	49

# Gastro-Enteritis and Mastoiditis in Infants

In some, a combined otitis media and pneumonia were present, but if myringotomy disclosed pus, the case was considered in the middle-ear group. In very many of such cases, the combination of these two infections was a fatal one. Mastoiditis was exceeding rare with a co-existent pulmonary infection, though the latter was often the preceding condition. It might therefore be more accurate to combine the middle ear and pulmonary groups, which would give a 30 per cent. for respiratory tract infections, but this tends to confuse the picture somewhat and as far as possible they are grouped separately. This possible source of error is not present where mastoiditis occurred.

## Mortality

There were 87 deaths in all, giving a rate of 33 per cent. This number was made up of the following :

(1) Middle-ear (including mastoid) Infections	18
(2) Pulmonary Conditions .. .. .	19
(3) Urinary Conditions .. .. .	5
(4) Other Causes .. .. .	45

Again the combined middle ear and pulmonary infections may be considered together, accounting for 25 deaths, or 28 per cent.

Middle-Ear Group	Total number.	Recovery rate.
(1) Otitis Media (spontaneous or treated by myringotomy)	28	79%
(2) Mastoiditis .. .. .	40	70%

In ten cases mastoidectomy was performed, with negative findings. In some of these the diagnosis was wrong, in others, the operation was of an exploratory character, no other cause being determined for the symptoms. In one case again, mastoid infection was diagnosed clinically, but owing to the almost moribund state of the patient operation was considered useless, and at post-mortem, pneumococcal pus was found in the bone. This was the only instance of untreated mastoiditis in the three year period. Despite this example, there were two cases who vomited coffee grounds on the "table", and in whom operation was successful. If fatal issue does occur, it usually does so, in my experience, within three to five days after operation; after this the prognosis is quite favourable. One must emphasize that a successful result can be attained only if there is a continuance of accurate and skilled medical attention afterwards. It is noticeable in many that an increase in the weight will occur perhaps for the first time for weeks, within a day or so of operation

## Bacteriology

The records are incomplete, but where cultures were taken, there was a predominance of pneumococci. Staphylococci and streptococci were less common.

## B. Cohen

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## Gastro-Enteritis and Mastoiditis in Infants

and also in later years, that mastoiditis is extremely rare as a concomitant of pneumonia. Otitis media may occur but it very seldom proceeds to mastoid involvement. One must presume that if there is pus in the middle ear cleft, despite the apparent lack of reaction in the tissues, some toxic absorption occurs *via* the blood or lymphatic stream. Leathart describes a constant finding of small glands in the posterior triangle of the neck, these were seen only in an occasional case in my own series of cases. Well defined changes on the drum are often seen rather late in the course of the illness, but by this time mastoid involvement is probably present. In my experience this state of affairs is reached between the third and fourth week, this late development of bone infection may be due to the general lack of tissue reaction. The infant is so dehydrated that it is not unexpected that the infection should appear to be an indolent one. If one presupposes that otitis is a complication of the alimentary disorder the same premise should hold for pulmonary infections, and here the argument is obviously wrong, as in the latter type a respiratory tract infection is usually obvious from the onset.

### Diagnosis

It is in the question of diagnosis that the main difficulties of the surgeon become manifest, but with close co operation between physician and surgeon the progress of the otitic infection can be closely followed and much of the difficulties minimized. It is useless for the surgeon to be consulted in the penultimate stages and on one examination requested to give an opinion on a drum head. Frequently an initial scepticism is confirmed by the occurrence of a fatal issue despite operative treatment and positive findings. The child is so toxic and dehydrated at this stage that operative interference will surely accelerate the fatal outcome.

Otoscopic changes may be evident during the first few days, but with rest in hospital and some form of isolation there is always an improvement in the clinical state and remission of otoscopic signs, except of course in the fulminating infections. In about a week or so the alimentary upset, never quite settled, flares up and often the temperature rises. Evidence of infection is now manifest in the tympanum. In my experience either of the following two sequences occur.

(1) The drum becomes increasingly injected and full until it is red and bulging and later greyish yellow. Pus will now be obtained by myringotomy. This may have to be repeated if improvement is only temporary, but when progressive deterioration proceeds there is an absolute indication for mastoidectomy. In this series almost 80 per cent of cases treated by myringotomy recovered. Such a drum seen later in the illness than the second week, e.g. third to fourth week, would indicate the need for mastoidectomy rather than myringotomy. It is difficult to assess how long one should temporize after a simple

paracentesis ; this is a matter of experience and relative to each individual case. There should, however, be some improvement within two to three days following the simpler procedure.

(2) In others the tympanic membrane loses its sheen, becomes dull and grey and sometimes there is a little desquamative debris lying on the surface, but generalized bulging does not occur. Any such fullness appears in the post-malleolar segment and may fuse into a mild sagging of the adjacent meatal wall. Naturally this is the more difficult type to diagnose as the pronounced dehydration may account for a certain loss of lustre of the tympanic membrane and even on normal drum heads in these children vessels can be seen. In my experience, it has been less common than the former type. This is the ear, too, which is usually "missed" and therefore the question of mastoid involvement may be raised only in the late stages. Probably what happens is that the infection finally involves the residual embryonic tissue in the attic and antrum, the rest of the middle-ear being relatively uninvolved. Myringotomy will not drain this region. Mastoidectomy must be done.

Spontaneous perforation does occur, frequently in a child not seriously ill. Deterioration in the clinical state will of course indicate the need for mastoidectomy. Some pyrexia is common during the illness, remittent in most cases. Long-standing cases are frequently afebrile. A point in otoscopic examination, which is alleged to introduce a fallacy, is the possibility of distention of the drum head as a result of the infant's crying. There is no justification for this contention; the drum undergoes no change whatsoever under such circumstances.

### *Treatment.*

There is little that need be said regarding the technique of operation. As a rule bilateral mastoidectomy was not performed unless otoscopic findings indicated the need for this, but exceptions did occur. A further few minutes spent in opening the other mastoid in no way lessens the patient's chances of recovery. In the first cases of this series, local anæsthesia, which included infiltration of the periosteum, was used, but owing to the obvious discomfort of the mastoid retractor and the possibility of dura mater being exposed, general anæsthesia was adopted. I found it rare for an infant to lie quietly through this operation sucking a bottle of glucose-brandy mixture. Nitrous oxide and oxygen produced no ill effects.

### **Summary**

(1) The literature on the subject of gastro-enteritis and mastoiditis is discussed.

(2) A series of 264 cases of gastro-enteritis is analysed and the incidence of middle-ear infections described.

# Gastro-Enteritis and Mastoiditis in Infants

(3) Forty patients required mastoid operation with 70 per cent recovery, and twenty-eight myringotomy with 79 per cent. recovery

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## CLINICAL RECORD

### MENINGITIS FOLLOWING MASTOID INFECTION BY BACILLUS PROTEUS\*

By MAX SUGAR, M.D. (Vienna), F.R.C.S.E.

*BACILLUS* *Proteus*, commonly pathognomonic for the urinary tract and the intestine, is very rarely found as the causal organism for middle-ear infection. There is no reason to believe that *B. Proteus* infection has become more frequent during the last two decades, and the recognition of it is certainly due partly to the routine examination of pus from the mastoid cavity obtained during the operation, and partly perhaps to improved technique in bacteriology.

Several authors (see Bibliography) have reported *B. Proteus* infection in different parts of the body, some of them describing infections of the ear with complications, e.g. sinus thrombosis and meningitis.

In 1940 Neter and Chait in Buffalo reported one case, in which culture of the material from the ear and the mastoid revealed streptococci, which were overgrown by a gram-negative bacillus, which turned out to be *Proteus vulgaris*. This case had shown, that although the *B. Proteus* was not the only micro-organism responsible for the disease, it was certainly an important contributing factor.

In 1941 Cragg from Cincinnati reported a case of *Proteus* infection. It was an acute exacerbation of a chronic otitis. At the operation a perisinus abscess was found and a modified radical operation performed. Immediately after the operation sulphonamide medication was started. From the pus of the mastoid and from the blood culture *B. Proteus* was recovered. As in his case the temperature continued to be high, the sinus was inspected, and having been found thrombosed, the internal jugular was ligated and the thrombus removed. A fortnight after the first operation a lung abscess developed and thoracocentesis had to be performed. From the pus obtained, *B. Proteus* with *Staphylococci* and *Streptococci* was cultivated. Cragg's patient recovered, which is remarkable, as out of about a dozen cases described so far in the literature on the subject, only two recoveries have been reported.

As regards the value of chemotherapy opinions differ. Cases of urinary infection seem to have reacted favourably, whereas otogenic cases seem to have been resistant to sulphonamide. Some of the authors are doubtful whether the value of chemotherapy in these cases can yet be determined, others believe firmly in its beneficial influence. The great mortality of cases, however, does not seem to show the striking results which are usual in uncomplicated streptococcal meningitis cases. Whether or not the effect of chemotherapy depends on the preponderance of the *B. Proteus* over the cocci or vice versa remains to be seen.

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\* From the Nose, Throat and Ear Department under the charge of Dr. I. Simson Hall, The Royal Infirmary, Edinburgh.

# Clinical Record

## Case Report

The case which is reported here is that of an 11 years old boy who was brought to the Out-patient Department on 5th December, 1942, with a history of pain in the right ear for several days, discharge, headaches, giddiness and sickness for the last three weeks. The mother stated that he had had a discharging right ear for a long time.

Anterior rhinoscopy showed a deviated septum to the left and copious mucopurulent secretion on both sides of the nose. The tonsils had been removed at an earlier date, and on posterior rhinoscopy a small amount of flat adenoid tissue was to be seen. The left drum was retracted and showed an anterior scar. The examination of the right ear showed some bone tenderness over the anterior aspect of the mastoid tip, but also tenderness below the auricle and over the tragus. *There was a polypus filling up the external meatus with profuse secretion.* There was also an otitis externa.

Results of the examination on 5th December

	<i>Right ear</i>	<i>Left ear</i>
Whisper	1 ft	6 ft
(Tested with Bárány noise box)		
Weber's test	—	Lateralized to Lt
Rinne's test	negative	negative
Schwabach's test	normal (?)	normal
No fistula sign	Temperature 98° F	Pulse 120

On 6th December—Dizziness, vomiting in the morning, frontal headaches. Tenderness over the mastoid tip somewhat increased.

	<i>Right ear</i>	<i>Left ear</i>
Whisper (with Bárány noise box)	Not heard	
Without Bárány apparatus	4 inches	
Conversation Voice		
(With Bárány apparatus)	9 inches	

No fistula sign, no spontaneous nystagmus, no past-pointing error, only slight positive Rombergism with a sway to the right.

On December 7th—During the night the boy was sick and showed, in the morning, a slight spontaneous nystagmus to the right. The hearing tested with the Barany box had not changed since the day before and the temperature was still normal.

As it was thought that there was a labyrinthine irritation which might settle down and given an opportunity to perform the radical operation under more favourable conditions, it was decided as a preliminary to remove the polypus in order to achieve better drainage. At the same time sulphonamide medication was started, with 1 gram four-hourly. Thirty six hours after the removal of the polypus, however, the meatus was blocked again by a mass of granulations. Renewed examination showed no past-pointing, and no fistula symptom. Whisper was not heard in the right ear, conversation voice was heard at about 1½ feet, the nystagmus which had been directed the day before to the right, changed to the left, and was of first degree only. A radical mastoid operation was decided upon.

## Operation Notes

After removal of the cortical layer a large cavity was encountered, filled with debris and liquid pus. A swab for culture was taken. The cavity was then cleared of necrotic material and granulations, which were followed up through the antrum into the middle ear. No ossicles were found. The dura of the middle fossa, and the sinus were exposed and appeared to be normal. The horizontal canal was intact and there was no sign of a fistula along the medial wall of the middle ear. The lumbar puncture failed to obtain fluid.

On the evening of the operation the temperature rose to 102° F. in spite of the continued sulphonamide treatment and the next morning the boy was unconscious and had a marked neck rigidity. He died the following day.

*Bacteriological findings.* The culture from the swab of the mastoid cavity taken during the operation yielded pure *B. Proteus*. The smears from the pus taken at the post-mortem examination showed gram-positive cocci (probably streptococci) and gram negative bacilli (*B. Proteus*?), but no growth of these organisms was obtained.

## Post-Mortem Examination Report

Surrounding the right internal meatus a thin layer of soft yellowish-green pus was found both external and internal to the dura mater. The leptomeninges were diffusely congested and contained a small quantity of blood, more or less widely distributed over the frontal and parietal region of each cerebral hemisphere, but localized more particularly about the upper extremity of each Sylvian fissure. The subarachnoid space in relation to the inferior aspect of the pons and of both cerebellar lobes, especially the left, and most particularly perhaps in relation to the optic chiasma, was filled with soft yellowish-green pus, similar in nature to that described outside and within the dura. The brain was definitely swollen and showed marked uniform flattening of its convolutions. Section of the brain revealed nothing abnormal, but the cerebrospinal fluid in the lateral ventricles was turbid and definitely blood-stained. A block of bone from the region of the middle ear was excised for the purpose of discovering the route of the infection from the middle ear, as no satisfactory explanation had been found during the operation.

Serial sections were cut and Fig. 1 represents a section taken from one of these sections. It has to be remarked, that the same throughout the whole thickness of the bone and choice fell to this section solely because it was thought to be the most instructive and the most easily understood.

It shows distinctly three foci of accumulation of pus. In the middle ear (Fig. 1, A) in the internal meatus (B) and in the perilabyrinthine cancellous bone (C).

A problem of importance is the origin of the marginal infiltration to be seen in the cochlea (D) as it is an interesting fact, that the cochlea is for the most part free from infection, and the vestibule with the canals entirely free. It has been suggested that a lump of pus might have dropped out from the cochlea during the preparation of the specimen. This explanation, simple as it seems, makes it difficult to understand why the canals (E) do not show even a trace of infection, and why, if the suppuration had gone through the cochlea, the

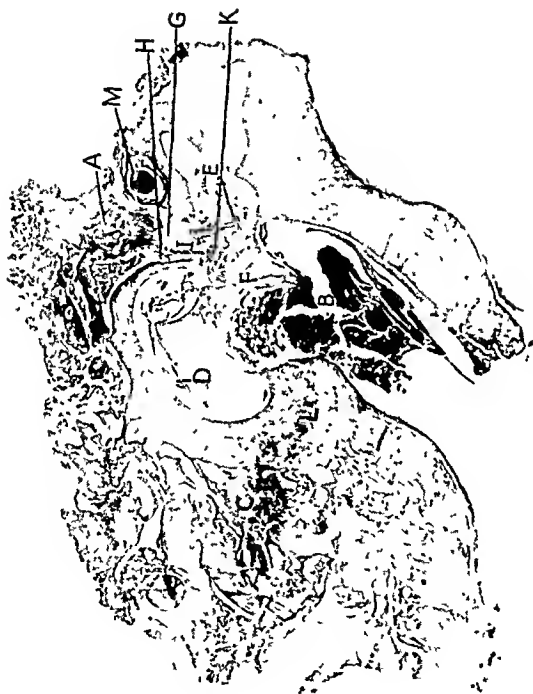


FIG. 1

## Max Sugar

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# CLINICAL NOTE

## POSTURAL INSTILLATION

### AN ADDED NOTE

By T/Major A. J. MOFFETT, R.A.M.C.

POSTURAL Instillation for the induction of local anaesthesia in the nose was first described when that technique had been used for no more than forty cases. This number appeared inadequate, but a description of the method was published as a preliminary note because it was evident that the principle was sound even if the details required modification, and because the opportunities for obtaining further cases seemed at that time to be remote. Since the original article was published I have used the technique for 160 additional anaesthetics and have also received considerable encouragement from the success of the method in the hands of other people. As a result some alterations have been made in the pre medication and anaesthetic solution, some difficulties discovered are pointed out, and it is hoped have been at least partially surmounted.

*Pre Medication* To the injection of Morphia gr  $\frac{1}{4}$  has now been added Scopalamine gr  $\frac{1}{16}$ , administered one and a quarter hours before the induction of the anaesthesia. This so subdues even the most nervous patient that the operation is unlikely to be interrupted by anything more disturbing than a snore.

*The Solution* The strength of the solution has been increased to 4.0 per cent Cocaine in 0.5 per cent Sol. Sod. Bicarb. freshly prepared on the morning of the operation. Four ccs of this solution with one c.c. of  $\frac{1}{1000}$  adrenaline hydrochloride is now used as the routine amount. The anaesthesia produced with this quantity and strength is so perfect that any increase in either does not appear to be indicated. The complete absence of any undesirable reactions to the cocaine suggests that a greater strength or a larger amount could be used if considered necessary.

*The Induction* The technique for instilling the anaesthetic remains unchanged. Three positions are assumed by the patient, each of which is maintained for ten minutes measured by the clock.

*First Position* The nostrils are first cleansed with spirit. The patient then lies upon his left side with a pillow under his left shoulder. Using this as a fulcrum the head is allowed to drop in the strictly lateral position until it assumes an angle of 45 degrees with the vertical. One-third of the total solution is drawn into a small syringe on which is mounted a knob ended, angled needle with lateral hobs depicted in the original article. As an improvisation an ordinary glass dropper can be used. A drop or two of the solution is first massaged into the anterior part of the septum. The remainder is divided equally between the two sides of the nose by introducing the needle along the

floor of the nasal cavities and squirting half of the contents of the syringe into each.

*Second Position.* At the end of the requisite ten minutes the second third of the anaesthetic solution is similarly divided between the two sides of the nose, the patient pinches his nose with his right forefinger and thumb and maintaining his grip to prevent the fluid running out, rolls forwards on to his face. It is here that the increased strength of the pre-medication may cause trouble. The patient is sometimes so sleepy that he allows his grip to relax and a little of the fluid runs out. If the head is well flexed the amount that escapes is not sufficient to affect the anaesthetic.

*The Third Position* is then assumed. It is similar to the first position except that the patient lies upon his right side. It is important when assuming this position that he should not relax his grip upon the nostrils until the pillow under the shoulder has been arranged, and that the head is raised as little as possible during the change. It is also important that he should roll directly from the prone position on to the right shoulder, and not first on to his back as is sometimes done. If this happens any unabsorbed solution will run down the throat and be lost for anaesthetic purposes as well as possibly producing unpleasant symptoms. When the third position has been assumed the remainder of the anaesthetic fluid is divided between the two nostrils.

If a septum operation is to be performed it is usually necessary to inject the columella and base of the septum with one or two c.cs. of 1.0 per cent. Novocaine or some similar anaesthetic. A wait of many minutes between the completion of the anaesthetic and the beginning of the operation can be made without any detriment to the anaesthesia.

*Post-Operative Problems.* It does not appear that there is any greater tendency to post-operative haemorrhage when this technique has been employed. It has been said that there is a liability for a post-operative haematoma to form in septum operations as a result of the injection of Novocaine and Adrenaline used to anaesthetize the region of the columella. It is probable that the haematoma is produced because the anaesthetic method provides such a bloodless field that a technically perfect operation becomes much more likely. If it is the surgeon's custom to suture the septum incision, and no alternative drain has been inadvertently made, it is advisable to incise the muco-perichondrium near the floor of the nose on one side, in order that any blood between the two layers will have an easy way of escape.

*Difficulties.* While patients with gross polyposis who have not been previously subjected to any surgical interference accept the anaesthetic readily, difficulty is sometimes experienced with those who have been the victims of multiple operations in which large portions of the turbinates have been removed while suppuration continues undrained in the sinuses. This difficulty is due to the fact that contact between the anaesthetic solution and the mucous membrane is hindered by the presence of pus, and because the scarring produced by previous operations has made the mucous membrane unabsorbent. Should the surgeon feel himself compelled to interfere further with these cases this difficulty can generally be overcome by cleansing the nose of all crusts by forceps or douches and by emptying the sinuses of pus by daily suction displacement treatment for a few days before operation.

## Clinical Note

I now consider that the principles upon which the technique of Postural Instillation has been founded have been shown in practice to be sound. I do not doubt, however, that various improvements and modifications will be effected in the hands of other users. I am indebted to numerous colleagues for their direct and indirect communications of criticism and advice on the technique. The needle used in the instillation may be obtained from P. Harris & Co. Ltd, Edmund Street, Birmingham.

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without resorting to skin flaps. In the event of a very wide resection of growth, a gap could be deliberately left between the divided ends and bridged in this way by a tube—a procedure which would not be possible with the endothoracic method.

By postponing the mobilization of the stomach the operation could be performed in two stages with benefit in the case of a feeble patient. It could be performed from the left side as well as the right and was applicable to growths of the lower œsophagus and cardia. It could therefore be adopted in the latter type of case if for any reason an endothoracic anastomosis could not be obtained. The new gastro-œsophageal region would lie permanently beneath the skin. Here it could be manipulated if any obstruction should occur, it could be controlled if regurgitation were troublesome and it could be palpated periodically for recurrence of growth which would then be easily accessible to further treatment by surgery or by X-rays. (*Précis.*)

W. M. LEVITT: In December, 1933, I showed to this Section seven of a series of eight cases of carcinoma of the œsophagus treated during the previous nine months by a strip-field method of deep X-ray therapy (*Proceedings*, xxvii, 368). All had had a high degree of œsophageal obstruction and all seven patients were able to swallow quite easily.

Skiagrams of seven primarily successful cases were shown, and in all seven, radiographic evidence of the disease had disappeared. In all, eight cases had been treated by this method up to the time of the communication but the eighth had died of an empyema before treatment could be completed. It was, of course, not to be expected that all these patients would be cured, but at least it seemed reasonable to hope that one or two of them at any rate, would survive for a long time. However, I now know that carcinoma of the œsophagus is still incurable. Remarkable palliation can be achieved by radiotherapy in selected cases but without such careful selection the price paid by the patient for a brief palliation can be too high.

Experience gained over the past twenty years has taught me to recognize the cases which should definitely be refused for radiotherapy, and if one accepts only cases which have been carefully selected I believe that the palliative value of X-ray therapy is considerable.

The subsequent history of these seven patients was as follows. Five of them sustained, as a result of their irradiation, such damage to pulmonary tissue that their deaths were ultimately determined by this, and not by their growths. In these cases, from six weeks to four months after treatment, the patients, while still swallowing well, began to complain of dyspnœa. The most careful clinical and radiographic examination failed at the beginning to reveal any cause for this dyspnœa. There was no cough and no other symptoms. Gradually the dyspnœa became worse until eventually the patient could only speak a few words without pausing for breath. By this time a diffuse fine fibrosis was observable in the skiagrams in the neighbourhood of the lung roots and the fibrosis gradually spread. Four of the six patients succumbed within a few months to acute infections which would probably have meant no more than an ordinary cold, had it not been for the lung damage. One patient, a woman with a middle-third growth, lived for nearly three years and then died of cardiac failure with generalized œdema and effusion into all the serous cavities. At

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autopsy no trace of carcinoma could be found in her body but a condition of brown atrophy was shown in the heart muscle which was attributed to the X-ray treatment. The seventh patient remained well for close on five years although the œsophagus had to be dilated from time to time for a fibrous stricture. He then got a recurrence which was treated without benefit and he died of his disease. This patient had no pulmonary symptoms throughout. The growth was in the upper third.

Modifications of the original method were then made in the direction of narrowing the beams still further and wherever possible reducing their number. It was found, however, that every attempt to reduce the width of the beam and thereby the size of the periœsophageal shell of tissue irradiated, was followed by a reduction in the proportion of primary disappearances of the growth and a reduction in the duration of the palliation. In spite of ten years of fairly steady advance in radiotherapeutic technique, I do not think the position has improved very greatly except in the upper-third growths. It is true that improved machines, and especially the super-high voltage machines, have increased the depth efficiency of our techniques and have enabled us to obtain better dosage distribution in the neighbourhood of the œsophagus while restricting lateral spread. Moreover accurate methods of beam direction have been introduced and knowledge of dosage distribution has improved. All these advances enable us to secure a better degree of palliation without lung damage. It is, however, still impossible to reproduce results, by X-ray therapy alone, approaching those obtained in the original series without inflicting some injury on the lung.

In selecting cases for treatment it scarcely needs stressing that patients with marked cachexia or with secondary deposits, or patients with complications such as cardiac or pulmonary disease, should not be submitted to radiotherapy. The most important contra-indication to radiotherapy, however, is mediastinitis. This is the condition which results from the spread of sepsis, perhaps associated with actual spread of growth through the œsophageal wall with consequent infection of the mediastinum. There are two cardinal signs of this condition which should be widely known as they constitute an absolute contra-indication to radiotherapy. First substernal pain, sometimes described as "shooting through to the scapula". The second, and more important, is persistent tachycardia usually without pyrexia. This latter sign I first described in 1934, and ten years of further observation have confirmed that it is a reliable guide to the presence of mediastinitis. I can safely say that I have never known a case of carcinoma of the œsophagus exhibiting this sign of persistent tachycardia not made worse by radiotherapy. If substernal pain is not already present it very soon makes its appearance after the initiation of X-ray treatment. As the radiation dose mounts up so that pain becomes worse and it can become so severe that the patient may be driven to suicide. Therefore no case of carcinoma of the œsophagus with persistent tachycardia with or without substernal pain should be submitted to radiotherapy. No case of carcinoma of the œsophagus with severe substernal pain, even in the absence of tachycardia should be submitted to radiotherapy. Pain is not a result of X-ray therapy in carcinoma of the œsophagus except in the presence of mediastinitis.

We have next to consider the influence of the site of the growth on the result. By far the best results are obtained in the upper third of the œsophagus while the results in the lower third of the œsophagus are so bad as to make treatment not worth while. Many of them are really growths of the cardiac end of the stomach. It is possible that some cures may even be obtained in the upper third. I have two cases which seem to be qualifying for inclusion under this term. The 'middle-third cases give intermediate results.

The type of growth itself is important. The growths that show fat, fleshy fungations into the lumen of the œsophagus, usually well demonstrated in the skiagram and easily seen by the œsophagoscope, do best. Usually these growth are associated with a considerable periœsophageal shadow and they require treatment with rather wider fields although dosage need not be so high as to place the lung in danger of injury. First-class palliation can be obtained in these cases for a time which may vary from a few months to a couple of years or more.

To sum up, cases which should be excluded are those with signs of mediastinitis, pulmonary extension, secondary deposits and those with growth in the lower third. In the absence of the first contra-indication, every case showing large fleshy fungations is worth treating.

We must also remember that, as we have seen, with suitable dosage and distribution of radiations to the œsophagus and disregarding the lung, a very remarkable percentage of primary regressions can be obtained. The problem is largely one of dosage and dosage distribution. It is therefore pertinent to inquire whether, by judicious combination of X-rays with intracavitary radium, a sufficient dosage and a suitable dosage distribution would be obtained without undue lung exposure. I had just embarked in 1939 on a combined method of treatment when the outbreak of war cut short this work. If there is to be any hope of real cure of carcinoma of the œsophagus from radiotherapy, I think it must come on these lines, although it is *possible* that the further development of supervoltage therapy may contribute to solving our problem.

G. H. STEELE: The outlook for a patient with carcinoma of the œsophagus is indeed gloomy because we are dealing in the majority of cases with a poor half-starved old man with a growth which has already spread to his vitals. Realizing this, we can merely try to relieve his dysphagia without attempting to cure his growth; in this category fall dilatation, intubation of the stricture, and gastrostomy. And when we boast of cures by other methods, do not let us forget the long periods of survival which occasionally follow such palliative measures alone.

We are dealing with a squamous epithelioma for which the obvious remedy is irradiation: but we have just heard Dr. Levitt's evaluation of the disappointing results of deep therapy; and there is remarkable unanimity among general practitioners who have to look after these cases subsequently as to how ill they are after intensive radiotherapy. As regards radium in the lumen, ten years ago the late Mr. Cleminson told this Section that he had treated 200 cases thus, and had come to the conclusion that they were better left alone. Some hope lies in the introduction of radon seeds through the œsophagoscope; and in spite of the inevitably hit-or-miss dosage due to difficulties in estimating the volume of growth to be irradiated and placement of the seeds, 50 to 70 per cent. of cases obtain great relief with a minimum of upset—a short anæsthetic, a

minor operation, and a brief stay in hospital. Swallowing is restored for six months or so, at the end of which the patient dies rapidly instead of lingering for the whole of the time. Dr. Jobson and I have thus seeded 60 cases, there has been no operative mortality, the majority have been greatly improved, and we have had four three-year survivals. I operated upon a woman of 76 before the war, she is now 82 and swallowing quite well. At one time we tried seeding the lower end of the growth by retrograde transgastric œsophagoscopy as well, and although the distribution of the seeds was improved we came to the conclusion that the end-results were no better, while the patient was subjected to two operations instead of one.

The only justification for surgery is the poor cure-rate obtained otherwise. The ideal cancer operation is removal of the growth and glands in one block, but the application of this principle to the œsophagus bristles with difficulties. The thoracic œsophagus is inaccessible, and few of these poor-risk patients will stand a formidable thoracotomy. The growth spreads early to irremovable structures and secondary deposits are found from the neck to the abdomen, Churchill (1942) quotes figures showing that half of the growths at the lower end, and even one-third of the growths of the mid œsophagus metastasize below the diaphragm. However, as Grey Turner (1943) has said, removal of the œsophagus has been shown to be feasible, restoration of continuity is a more difficult problem. Direct anastomosis is obviously the most desirable course, but the œsophagus is poor material, it has no peritoneal coat, it is so friable that stitches cut out easily, and its septic contents are liable to infect pleura and mediastinum. The two ends can be brought to the surface and joined by a tube of skin or intestine, but the majority of cases published in this country show that the unfortunate patient is subjected to many operations and is usually dead before the last one is completed. The openings can be joined by a rubber tube but what a life!

Once the patient has been operated upon he has several stiff fences to surmount. If he does not die of shock in the first twenty-four hours, if he does not collapse or develop œdema of the lung in forty-eight hours, if his anastomosis does not leak at the end of four to five days, and if he does not develop an empyema in a week he has a good chance of survival.

I have two cases to report. Both had growths of the lower end of the œsophagus treated by left-sided transpleural resection, the diaphragm was opened, the stomach freed and brought up into the chest and anastomosed to the stump of the œsophagus. Both subsequently swallowed full meals normally, the first, a woman of 52, survived seven months and died of a recurrence, the second a man of 72, was only operated upon three weeks ago, but he has left hospital perfectly well. He had relatively little dysphagia in spite of a big growth, which raises the question as to whether dilatation of the stricture might be preferable to gastrostomy as a means of pre-operative improvement.

œsophagectomy now appears to be where gastrectomy was thirty to forty years ago. It has been shown to be feasible but the indications for its employment, except perhaps in growths of the lower end, are not yet fully established.

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M. LEDERMAN: The radium procedures available for the treatment of cancer of the œsophagus are: (1) External radiation by teleradium; (2) intracavitary treatment by radium bougie; (3) implantation of radon seeds. The technical method employed will depend on the part of the œsophagus affected and the purpose of treatment, whether cure or palliation.

Œsophageal cancer can be subdivided into pharyngo-œsophageal, mid- or thoraco-œsophageal and cardio-œsophageal tumours. This includes all neoplasms affecting the upper and lower ends of the œsophagus irrespective of site of origin. Whether an œsophageal tumour is primary in origin, or secondary to disease in the hypopharynx or cardia is of no great importance as far as planning of the radiation fields is concerned.

*Pharyngo-œsophageal tumours.*—Included in this group are tumours which are either limited to the cervical œsophagus or affect both this structure and the hypopharynx. These tumours are eminently suitable for teleradium treatment provided they do not extend below the 1st dorsal vertebra, as once the upper thoracic aperture is passed the tumour becomes too deeply situated for efficient radiation by teleradium, and high voltage X-ray therapy is indicated. High voltage X-ray therapy can, of course, be used as an alternative to teleradium for all cases, but the latter method has certain advantages of a technical biological and physical nature.

*Mid- or thoraco-œsophageal tumours.*—There are two methods of radium treatment: A. Treatment by radium bougie; B. Treatment by radon implantation.

Because of the depth of the thoracic œsophagus below the surface teleradium treatment with present-day apparatus is not a satisfactory or economic alternative to high voltage X-ray therapy.

A. *Radium bougie.*—When treatment by radium bougie is undertaken a meticulous technique is essential. The chief features of the technique used at the Royal Cancer Hospital are as follows: (1) Accurate localization of the tumour; (a) Distance of upper edge of tumour from the upper incisor teeth obtained by œsophagoscopy; (b) length of the tumour. Information obtained by œsophagoscopy or X-rays. The length of œsophagus irradiated should be such as to include a wide margin of normal tissue above and below the tumour.

(2) The lumen of the œsophagus should be wide enough to take at least a No. 28 French œsophageal catheter. In some cases gradual preliminary dilatation of the œsophagus may be necessary. The greater the diameter of the catheter the better is the distribution of the radiation in the tumour. The size most commonly employed is a No. 30 French.

(3) Irrespective of the site of the primary growth the bougie must fill the whole length of the œsophagus. A short catheter or radium mounted on a Symonds' tube are unsatisfactory because they tend to be displaced upwards and it is difficult to be certain of their exact position during treatment.

(4) The radium tubes used have a linear density of 10 mg./cm. with an active length of 25 mm. and an overall length of 35 mm. Each is placed in a brass container 44 mm. long, and the total filtration is 1 mm. Pt. equivalent. Tubes of higher linear density tend to give too intense a radiation, whilst tubes of lower linear density mean undue prolongation of treatment time. The bougie itself acts as a secondary filter.

(5) The containers should always be inserted so that the lowest appears at the catheter eyelet, which is filled in with wax before treatment is begun. By having the containers extending in tandem upwards from the lowest fixed portion of the catheter, a stable position is maintained. In order to fulfil this condition for all cases the lower part of the catheter may be occupied by empty containers when treating tumours of the upper part of the thoracic œsophagus.

(6) Secure anchorage of the bougie by tapes passing above and below the ears, coupled with vigilant nursing and observation are vital if the bougie is to remain in the selected position. X-ray examination after the first insertion should be performed as a routine.

(7) A divided dose method of treatment is employed. The bougie is inserted on alternate days and, using 25 mg. tubes, the total treatment time is sixty hours spread over fifteen days. By prolonging the treatment time, using relatively low radium content tubes, and employing the "shift" method to be described below, localized zones of intense radiation with consequent massive tumour necrosis are avoided.

(8) If the radiation field produced by a bougie constructed in this manner is examined, it is found that the radiation tends to be concentrated in zones in proximity to the radium-containing part of the tube, the inactive ends of the tubes and the ends of their cylindrical containers producing gaps where little radiation is given. The œsophagus is not a rigid, immobile structure and a certain amount of movement of its walls, partly inherent and partly transmitted, occurs. It is, however, both hazardous and unscientific to rely upon the vagaries of such movements to even out these differences in dose. The regions of under-dosage beneath the inactive portions of the radium container can be eliminated by arranging for a shift equal to half the length of one radium container, i.e. 22 mm. Deliberate steps are therefore taken for alternate treatments to be given in one of two different bougie positions. The shift not only eliminates the gaps but it also reduces the dose at the surface of the tumour from 20,000 r to 12,000 r with only a slight reduction in dose to points further away from the bougie.

**B. Radon seed implantation.**—Radon seeds can be used for insertion either through an œsophagoscope, or after transpleural exposure of the œsophagus. The disadvantages of these methods are that: It is impossible to insert radon seeds with the accuracy necessary for efficient irradiation of the whole tumour, and, moreover, the risks of perforation are not inconsiderable; it is doubtful if the risks associated with the operative procedure are justified for what can only be a palliative method.

**Cardio-œsophageal tumours.**—The abdominal œsophagus is usually affected secondarily by spread from an adjacent tumour of the cardiac end of the stomach. These cases are unsuitable for treatment by telerradium because of their depth below the surface, and a radium bougie cannot effectively deliver an adequate dose to the gastric part of the tumour; high voltage X-ray therapy however, can be used.

Since 1936 a certain number of these cases have been treated at the Royal Cancer Hospital by the implantation of radon seeds after laparotomy. It has been found very difficult to devise accurate methods of distribution of the radon

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seeds. The radiographic appearances after a barium meal are of little assistance when attempting to assess the exact site and volume of the tissue affected by neoplasm for purposes of dose estimation. Again even after laparotomy these extensive, rather inaccessible tumours do not lend themselves to simple geometrical methods of radon seed distribution. As a routine we employ a maximum of 60 mc. of radon distributed as evenly as possible throughout the tumour tissue, in the form of seeds 6 mm. long, 0.3 mm. Pt. filter and 2 mc. content. The seeds are inserted into the tumour substance *via* the serous surface and penetration into the lumen of the stomach is avoided. The risks of peritonitis following this procedure are small. Although the seeds are left in permanently, about 10 to 15 per cent. find their way into the bowel and are usually passed without incident. This method can obviously only be recommended as a last resort.

*Results of radium treatment.*—Out of a total of 15 cases of pharyngo-oesophageal tumours, three have been living symptom-free for a year, and one has developed metastases within that time; four died from intercurrent disease within four years, one from distant metastases in less than two years, and six died of their disease within one year. Although these results are not very striking, five of the cases died without any evidence of disease in the treated area. Out of a total of 15 cases, 7 had lymph node metastases, 4 of which disappeared after treatment with recurrence in 1. There was primary healing in 12 cases with local recurrence in 2 cases.

In 38 cases of mid-oesophageal tumours 33 were treated by radium bougie and 5 by radon seeds. One survived two and a half years; the others died within six months.

In 15 cases of cardio-oesophageal tumours there were 2 post-operative deaths. Of the "useful" survivals on whom no gastrostomy had been performed there was one five-year survival, a patient under the care of Mr. R. C. B. Ledlie. Unfortunately there is no histological confirmation. One died of the disease in nineteen months and 3 died of the disease in six months.

### Comments

The best results yet obtained in the treatment of carcinoma of the oesophagus were those obtained by Guisez using a radium bougie. Unfortunately nobody seems to have been able to equal, much less emulate, his results. Of 270 cases treated by Guisez 11 survived more than three years, 12 survived over eighteen months, and 4 died of intercurrent disease.

We have only had two survivals of appreciable length of time. One patient not included in this series was treated by Mr. Lawrence Abel in 1927 and died of intercurrent disease eleven years afterwards. The longest survival in this series is two and a half years.

No statistical table, however, can give any true picture of the palliative value of the bougie. The rapidity with which symptoms are relieved and the avoidance of gastrostomy are of incalculable value to the patient.

The treatment of cardio-oesophageal tumours by laparotomy and insertion of radon seeds does seem a worth-while procedure in an otherwise hopeless case.

## ACKNOWLEDGMENTS

I wish to express my indebtedness to the members of the Surgical Staff of the Royal Cancer Hospital for sending the cases, and their co-operation in the treatment. I am particularly indebted to Mr. A. Lawrence Abel and Mr. R. C. B. Ledlie for permission to quote two of their cases. My thanks are also due to Dr. D. W. Smithers, Director of the Radiotherapy Department, for the loan of material and helpful criticism. Dr. Clarkson, Assistant Physicist to the Royal Cancer Hospital, suggested the "shift" method and was responsible for the investigation of the physical conditions of the various radium techniques discussed.

Lieut.-Colonel W. L. HARNETT, Medical Secretary to the Clinical Cancer Research Committee of the British Empire Cancer Campaign, brought forward statistics of the results of treatment of carcinoma of the œsophagus collected by the Committee. Out of 15,200 cases of cancer registered during the seventeen months from April 1st, 1938, to September 3rd, 1939, when the registration of new cases ceased, there were 470 cases of carcinoma of the œsophagus, about 3 per cent. of all cancer cases, approximately the same percentage as the Registrar-General's figures for England and Wales. There were 397 males and 76 females, a ratio of 5 males to 1 female, the same proportion as Vinson found in a study of 1,000 cases at the Mayo Clinic. The mean age of the males was  $64.67 \pm 0.43$  years and of the females  $61 \pm 1.30$  years, the difference of the means  $3.03 \pm 1.37$  being probably statistically significant.

Of these 470 cases, metastases in lymph nodes were recognizable clinically in 80 cases and distant metastases in 44, leaving 346 cases in which the disease, judged by clinical findings, was still local.

*Methods of treatment* used in these 470 cases were: Surgical, 205 cases; radium, 43 cases; X-rays, 139 cases. 105 cases received no treatment and 22 cases refused or abandoned treatment.

The thorax was explored in 17 cases and œsophagectomy was performed in 5 of these, all of which were operation fatalities. The operation mortality of thoracic exploration alone was 58.3 per cent. Only 6 of the patients were alive at the end of the third year and in only one of these was the diagnosis based on a biopsy. The average duration was  $9.31 \pm 0.31$  months. To assess the results of treatment it is necessary to allow for the varying expectation of life in groups of patients of either sex and of different ages and to calculate the ratio in each group between the *actual* duration of survival over a 3-year period of observation and the *expected* duration in a similarly constituted group of the general population. Calculated in this way it was found that cases treated by implantation of radon seeds had their expectation of life lengthened by two months, whilst in a group of 102 cases treated by deep X-ray therapy the average period of survival was twelve months instead of nine. The use of intracavitary radium in 26 cases did not increase the duration of survival.

For statistics see 19th *Annual Rep., British Empire Cancer Campaign*, 1942, 65-73.

D. W. SMITHERS said that he found it hard to believe that surgery was the answer to the problem of the treatment of carcinoma of the œsophagus. The quality of the life of those few patients who did survive was by no means enviable, whereas a patient who survived after radiotherapy swallowed normally.



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With modern X-ray techniques based on an estimation of the volume distribution of the energy absorbed, radiotherapy should achieve better results. He had treated over 100 cases with X-rays, 80 of them more than two years ago, and had not seen a single case of fibrosis of the lung in spite of the fact that 20 of these patients had lived for one year or more. Three patients were alive and free from symptoms more than five years after treatment (one after seven years, one after five years and nine months, and one after five years and five months, two with microscopical confirmation of the diagnosis). Of 32 patients who completed treatment before the war 30 had marked relief of symptoms and 11 became symptom-free for varying periods of time. No complete follow-up had yet been possible for patients treated during 1940 and 1941, but 12 were known to have been symptom-free at one period, and one of these, at least, for more than two years.

X-ray treatment could deal with the local growth in a reasonable proportion of cases, but the majority died from perforation or distant metastases. In eleven post-mortem examinations on patients who completed treatment there was definite evidence of persistence or recurrence of local growth in only three. X-ray treatment offered a means of relieving symptoms in quite a good proportion of these patients and produced an occasional five-year "cure", in fact it offered many of these patients useful palliation and provided some hope of survival. The literature showed that a five-year survival had followed radiotherapy in a number of patients; he was able to find ten to set against the only two surgical successes (Torek and Garlock) of the past thirty years, and when one considered the amount of palliation produced he thought that the evidence was strongly in favour of radiotherapy as the treatment method of choice.

One possibility for the future lay in a combination of radium and X-ray treatment. The chief trouble with the insertion of a radium bougie into the oesophagus was that the high local dose and trauma increased the risk of perforation. If a much smaller dose was given with radium and if this was supplemented by external high-voltage X-rays, the position might be improved.

V. E. NEGUS said that if the patient were in good condition, even with small glands, he believed the method described by Mr. Trotter of excision was worth considering. It was possible by excising the upper end of the oesophagus and reconstructing it with a skin tube to restore swallowing and to give the patient a happy life for some time. If for any reason the growth was intruding into the mediastinum it might be unsuitable for operative treatment, and local implantation of radon seeds outside the oesophagus might be practicable.

In cases of carcinoma of the thoracic oesophagus he too had tried to use radium in containers as described by Dr. Lederman, but had found that the only method which gave satisfactory results was the implantation of radon seeds. One could put the radon seeds into the bottom of the growth as well as into the top by using a proper depth indicator. It was, however, rather a haphazard method and he found that the better way was to couple the seeds together with links of catgut; an alternative method was to put the radon seeds into a small tube of silk. One examined the growth and measured it by passing bougies through and then made up a series of columns or chains of

seeds, four or five in each according to the length of the growth. They were introduced through a wide bore œsophagoscope which had on it an arm so arranged that it held the stylet in position after an introducer had been passed in with the chain of seeds inside it. It was possible with these columns of seeds to give a fairly even distribution, and they were mutually self-retaining. By this method it was impossible to cure a growth, because of the outward extension, but it was almost always possible to restore swallowing with very little discomfort to the patient, and although the patient's life was not prolonged it did allow him to swallow in a normal way not only food but, what was more important, saliva. These people died from perforation if the growth were in the region of the trachea or bronchi and death might be precipitated by the introduction of the seeds, but it only anticipated what would happen and accidents seldom occurred. The patient suffered very little disturbance. Seeds in the silk tube should be removed after ten days but catgut-coupled seeds should be left in position.

This was a method which could be considered in comparison with deep X-ray therapy as being very brief and with no effect on the lungs nor upset to the patient, who did not know that he had had more than a simple œsophageal examination.

A TUDOR EDWARDS said that some years ago he had carried out operations on 8 patients, 2 of whom were operable. In both cases it was possible to remove the growth. One was a woman of 60 who made a temporary recovery but died a month later from a purulent pneumonia. The second, a woman of 58, was shown to the Section in 1935 (*Proceedings*, xix, 188). She had almost a complete resection with the small portion of the upper œsophagus brought out of the neck and later connected with a rubber tube to the gastrostomy. She was the first patient in this country to be operated on by the transpleural method with the removal of the œsophagus. She died of recurrence seven months later.

In 1940 he had 7 cases, 3 of which were operable. One patient had a growth about 4 ins. from the lower end and was treated by radical procedure bringing out the upper œsophagus on to the chest. The operation was performed three years ago and the patient was still alive and free from symptoms. She had carried on with a tube. The question of a rubber tube was a question of the patient's persistence. Some people would get comfortable because they meant to do so and others would determine from the beginning that they would not be comfortable. He had left this patient alone and had not tried to carry out reconstruction. Skin tube reconstructions were very unsatisfactory. They should not be attempted too early. Many cases of successful resection of the œsophagus had died from pneumonia following the attempts of reformation of a gastric tube or skin tube for anastomosis. One should wait a long time before doing that.

At a recent meeting of the Society of Chest Surgeons nearly all those who had done partial resections of the œsophagus reported that fistulas occurred where they tried to reform skin tubes. A case operated on by Professor Grey Turner, after holding for a short time, had a fistula which was present until the man died.

Other attempts had been made to use tubes made from the stomach which

# ABSTRACTS

## THROAT

*Tonsillectomy and Poliomyelitis.* J. R. PAGE. *Archives of Otolaryngology*, xxxix, 4, April, 1944.

Since the report by Krill and Toomey (*Jour. A.M.A.*, Sept., 1941) concerning five children in a family, all of whom developed bulbar poliomyelitis following the removal of adenoids and tonsils, a number of papers have been published on the relation of poliomyelitis to tonsillectomy. One of the most comprehensive was that of E. M. Seydell (*Archives of Otolaryngology*, Jan., 1942) who, after a full enquiry, was led to the conclusion that the bulbar (or most fatal) type of poliomyelitis appeared to be more common after recent tonsillectomies, but whether the tonsils exercised a protective influence against the disease was not apparent. The writer of the present article has carried the enquiry a stage farther by a statistical enquiry relating to 27,849 tonsillectomies, performed in New York during 1937, 1939 and 1941, the years in which poliomyelitis was prevalent. A total of 8,915 replies revealed only one case of poliomyelitis following the operation. Such a result suggests that there is no special relationship between the disease and the operation. Nevertheless, until other reports are forthcoming, the majority of laryngologists will follow the advice of Mosher and refrain from performing routine tonsillectomy during an epidemic of poliomyelitis.

DOUGLAS GUTHRIE.

## EAR

*Present Status of Diagnosis and Management of Ménière's Syndrome.* H. BRUNNER. *Archives of Otolaryngology*, xl., 1, July, 1944.

Ménière's syndrome is regarded by the writer as "hydrolabyrinth" analogous to "hydrocephalus". He claims to have described this dilatation of the labyrinth in 1922, although he did not then appreciate its significance, nor did he recognize that it resulted in a gradual destruction of the sensorial cells of the internal ear. The fluid, in his opinion, escapes from dilated and permeable blood vessels of the labyrinth.

The symptom complex consists of tinnitus, deafness and vertigo, the last-mentioned being the more prominent and often very intense. A Ménière attack may be simulated by hysteria, but in hysteria there is never spontaneous nystagmus nor can it be elicited by sudden head movement. Between the attacks, symptoms may be absent. There are two concepts of the malady: (a) the metabolic theory and (b) the vascular theory. In regard to the former, Furstenburg and others stated that the cause arose from retention of sodium and they advised a sodium-free diet and the administration of ammonium chloride to promote elimination of sodium. Mygind and Dederind, on the other hand, assumed that retention of water was the cause and they restricted the fluid intake. It is, however, difficult to understand why a disturbance of general metabolism should produce trouble limited to the ear. Mygind reports

cure in 42 per cent of cases and Furstenberg also claims a high percentage of good results, but it is not easy to assess the value of treatment in a disease which may undergo spontaneous cure. It was Ménière himself who propounded the vascular theory which is supported by microscopic findings.

The present writer believes that the condition is very often the result of cerebral arteriosclerosis. Tabes and injuries of the head may also produce the Meniere syndrome, while leukæmia must not be forgotten and any source of focal infection should be treated.

A Ménière neurosis should first be excluded. The personality of the patient, normal hearing, and absence of nystagmus should prevent any gross error. Among aural diseases, a chronic adhesive process is frequently a cause of Ménière's syndrome. Treatment is somewhat unsatisfactory. Most important is rest, physical and psychic, with sedatives if necessary. A salt-free diet has been advised.

Surgical treatment which involves destruction of the labyrinth, can be considered only when the diagnosis is certain, when conservative measures have failed, when the patient is incapacitated by the attacks, and when the disease is limited to one ear.

DOUGLAS GUTHRIE

*Ménière's Disease. Histopathologic observations.* J. R. LINDSAY. *Archives of Otolaryngology*, xxxix, 4, April, 1944.

The author opens his paper with a reference to the original work of Hallpike and Cairns who, in 1938, described labyrinthine dropsy (hydrops labyrinthi) in two cases of Ménière's disease, and notes that this pathological condition has since been found in sixteen ears examined, eleven of them being from patients known to have had Ménière's disease. The terms Ménière's "syndrome", "symptom-complex" have been applied somewhat indiscriminately. In the author's opinion the term Ménière's disease should be retained but should be restricted to cases of recurring vertigo with auditory disturbance, now known to be due to hydrops of the labyrinth, although the cause remains obscure.

The case now reported in detail is that of a man aged 47 years who fell during an attack of vertigo and died from fracture of the skull. Three years previously he had been examined at the Mayo Clinic, and was considered to be suffering from Ménière's disease. There had been noted a loss of hearing for high tones in both ears and also a loss for tones below 2,048 cycles. Of course a single test is of limited value, and considerable fluctuation of hearing capacity has been noted as a rule in such cases, the reaction being due, apparently, to alterations of pressure within the labyrinth. Microscopic examination of the temporal bones in the case now reported showed hæmorrhage and congestion in both ears, and also, in the left ear, dilatation of the ductus cochlearis, the saccule and the utricle. The appearance is clearly shown in five microphotographs.

DOUGLAS GUTHRIE

## ERRATUM

VOLUME LIX, No. 3. The X-ray Figure 2 facing page 101 should be reversed top to bottom.



# The Journal of Laryngology and Otology

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## CONTRIBUTIONS TO FUNCTIONAL PATHOLOGY OF THE EAR—II

### PRINCIPLES OF SENSITIVITY AND EFFICIENCY OF THE EAR

By F KOBRAK (London)

IN "Contributions to Functional Pathology of the Ear" —I (*J Laryng and Otol*, 1943, LVIII 444) certain cases of progressive congenital deafness were mentioned as improved, after inflation, for the spoken voice, but not for pure tone perception. This difference was referred to the different behaviour of auditory "sensitivity" and "efficiency."

The clinical bearings of the differentiation between sensitivity and efficiency will be given in a later paper.

#### Introduction

I *Sensitivity* is the basic and elementary physiological faculty of a sensory organ to perceive specific impressions, which is pure tone sensitivity in the case of hearing, pure directional or positional sense in the case of vestibular functions.

II "*Efficiency*" is a complex faculty.

*Auditory Efficiency* is (a) purely cochlear, or (b) "panaural", a combination of cochlear and extracochlear functions.

(a) This consists of the constituent elementary sensitivities of pitch the fundamental together with the overtones (harmonics), i.e. timbre, which, however, is not based on simple summation of tones, but on a certain "structural" interrelation of elementary sensitivities. This structural interrelation seems to secure, monaurally, some "compensation" between the constituents of the timbre of the tone, and of vowels.

and consonants, and, binaurally, an "equilibration" between the functions of both ears (*J. Laryng. and Otol.*, 1943, lviii, 11).

(b) This consists of the net result of cochlear and extracochlear functions, interrelated between pure tone sensitivities and muscular reflexes in the ear, and, in addition, psychological factors, such as concentration, fatigue, and combination.

*Vestibular Efficiency* shows some degree of analogy to auditory efficiency.

There are interrelated directional functions between the semicircular canals of the ear. They are based on "pure" elementary specific directional sensitivities in the individual canals. They were calculated by the author (*Monograph on Static Functions*, 1921) and experimentally confirmed by Fischer and Wodak (*Zeitschr. Hals. etc. Heilk.*, 1922, 198). They indicate a certain analogy to auditory monaural "compensation" between pitches. Vestibular "equilibration" between both sides (Ruttin's Compensation) is similar to auditory binaural "equilibration". There is, furthermore, a kindred relationship of auditory and vestibular "combination" in regard to the tonus resulting from a combination of the different functions of classical deep sensitivity (muscles, joints, etc.) and vestibular sensitivity. This vestibular "combination" is, of course, psychologically more primitive than auditory combination.

## General Discussion on Typical Conditions

### I. Sensitivity

#### (1) HEARING.

Tests for intensity thresholds using the audiometer or tuning forks are generally interpreted as tests for the threshold of hearing sensitivity. In practice, accurate tests can be done more easily with the audiometer than with tuning forks; but accuracy is neither the only nor the essential difference between the two methods of testing. The difference is a basic one, since audiometry is a test of pure sensitivity, whereas the tuning fork test is as much a test of efficiency, as will be explained later *vide infra* Hearing Efficiency Section II (1).

In contradiction to the usual estimation of intensity threshold, the problem arises as to whether an advantage can be expected from the estimation of the minimum period of time, which is needed to identify the tonal quality of a momentary acoustic stimulus: it might be called "Time threshold of definite tonal quality". The minimum period depends on the number of cycles required for a tone to be perceived as having a definite tonal quality (Stevens-Davis, *Textbook*, 100). By gradually increasing the tone's duration from a very brief period, say 2 or 3 millisecs. at 1,000 cycles/sec., the first sensation seems to be a pitchless click, by further increase a click with a certain pitch, and,

finally, by still further increase of the tone's duration a definite pitch is ascertained. The duration required for the identification of pitch is different, with different frequencies, below 200 cycles  $2/100''$ , at 1,000 cycles about  $1.2/100''$ , at 10,000 cycles about  $2.5/100''$  (Stevens-Davis). In a later paper on clinical bearings of sensitivity and efficiency, the significance of the "Time threshold of definite tonal quality" for the differential diagnosis between middle-ear and internal-ear disease will be discussed.

## (2) VESTIBULAR SENSE.

(a) Vestibular perception of one's own body is known to be related to three functions of the vestibular organ : sensations of :

- i. Acceleration in a straight line (linear acceleration),
- ii. Rotatory acceleration (angular acceleration),
- iii. Position.

The two former sensations are independent of the position—and not even dependent on the existence—of the outside world ; they are rather related to an initial position of the body, they are the sensation of a gradual positional change of linear or angular distance ("  $d$  ") of the body with reference to a specific period of time ("  $A$  "), and may be related to iii, the basic spatial sensation of relationship to the perpendicular, that is, gravity. The vestibular sensations of movement, viz. i and ii, have not so far been directly and objectively worked out in relation to " $d/A$ ". They were only directly and subjectively investigated by Fischer and Wodak in experiments on exact subjectivism (l.c.). Direct objective tests based on the relationship " $d/A$ " may, however, prove useful, in spite of the well-known poor sensitivity of the vestibular apparatus, e.g. the poor estimation of subjective sense of direction of the body, when visual control is excluded. Direct vestibular tests of linear or angular acceleration, or of position, would enable us to differentiate between abnormalities in the canals or utricle respectively, which, as de Kleijn has suggested, could be done by subjecting cases of Ménière's syndrome to varying positions of the head.

Technical difficulties in measuring the  $d/A$  relationship, and thereby finding the threshold of sensation for linear or angular acceleration, might be overcome. A labyrinth chair electrically driven, capable of graduated speed, was constructed by M. H. Fischer for use in other investigations. Graduated acceleration synchronized with a stop watch would allow us to test directly and objectively the  $d/A$  threshold for vestibular sensitivity.

As just mentioned, the vestibular directional sensations of linear acceleration are poor, but are probably, nevertheless, capable of being tested according to the principles of sensitivity. The conditions governing sensations of angular position seem to differ and not to be dependent



solely on the control of vestibular sensitivity. The specific "deep sensitivity" of the vestibular organ, pure vestibular positional sensitivity, seems to be practically out of the patient's control, when separated from the other combined factors of deep sensitivity (muscles, joints, etc.). Vestibular deep sensitivity—in *man*!—acts obviously only as a minor partner in the combined efficiency of the other leading deep sensitivities. The relationship of vestibular function to the other functions of deep sensitivity was explained (*Monograph on Static Functions*, 1921), by considering the vestibular organ (utricle) as the fine adjustment to the cruder sensations provided by the muscles and joints at rest. If the latter are lacking, there is no place for the subtler sensations of the utricle.

Spatial orientation of man to the outside world is mainly based on visual sensations, and on gravity, the latter producing a sensation by the weight of the body, or by shifting of this weight in relationship to the body, whether standing, sitting, or lying. When the guiding deep sensitivity at rest, the sensation of gravity, is critically decreased, and visual orientation is simultaneously lacking, that remaining deep sensitivity at muscular rest which is independent of gravity is poor, and there can be no pertinent vestibular deep sensitivity in relation to the angle of position.

Therefore, in tests designed to detect vestibular deep postural sensitivity, it must be duly taken into consideration that a combination of all deep sensitivities comes into action. These tests could be done, if observations of earlier years could be substantiated, by determining the angular attitude of the head with reference to graduated declination of the body, i.e. by deliberately eliciting the *whole* deep sensitivity system of a patient who is given the test to maintain or restore the vertical position of his head, against the experimentally enforced declination of the body. The patient's task is "restoration of subjective perpendicularity". The test registers the angle between subjective and objective perpendicularity; the angle is expected to differ from the normal in cases of abnormal vestibular (utricular) sensitivity.

(b) *Vestibular perception of the outside world*, though occasionally hinted at, is not generally acknowledged.

Vestibular sensation of the outside world was mentioned in reference to hearing. *Rhythm* is that part of the acoustic sensation, which, it was suggested, was not a pure acoustic phenomenon. Rhythm seems rather to be a feature of hearing based to a great extent on pressure stimuli, which are associated with, but possibly independent of, specific acoustic sensations in the cochlea. Rhythm, from the viewpoint of vestibular participation in hearing, can be regarded as a repetition of changes of intensity in mechanical pressure of the sound waves at regular intervals, for the perception of which the vestibular organ seems to be especially suited.

# Contributions to Functional Pathology of the Ear

The localization of autonomous sensation of regular rhythmical changes of acoustic intensity partly in the vestibular apparatus gives rise to the further question whether acoustic phenomena associated with features and changes of tone intensity as accentuation [*sforzando*] or mechanical non specific acoustic pressure as tonal phase or beats might be related to vestibular sensation as well. This question which cannot be discussed here broaches the whole problem of hearing of music and harmony and of the significance of rhythm as the mother of musical melody.

Vestibular participation in hearing, and therefore vestibular perception of the outside world should be considered also in relation to the problem of *directional hearing*, on the admission that the movement of fluid in the canals depends not only on rotation—angular acceleration—but also on progressive movement—linear acceleration.

This view though discussed coincidentally by Magnus and de Kleyn (1921 *Pflüger's Archiv f. ges. Physiol.* clxxvi 6) and by the writer (1921 *Static Functions Monograph*) seems to have been neither refuted nor generally adopted. By adopting the view *directional hearing* i.e. the problem of localization of the source of sound can be referred in terms of mechanical pressure to the degree of angulation between the direction of travelling sound and the direction of a basic line e.g. the perpendicular such as directional sensation of the movement of the body can be referred to the degree of angulation between the direction of linear acceleration of the movement of the body and the basic direction of spatial orientation i.e. the perpendicular.

Linear acceleration of progressive movement of the body causes a sensation of pushing. The alternative phases however of compression and rarefaction of the sound waves entering the cochlear cause a vibratory push and pull effect. While the phases of compression and rarefaction cancel out each other and thereby eliminate any sensation of *directional movement* nevertheless the angle of incidence of the sound wave causes a sensation of *direction* which is obviously identical with both phases independent of its plus or minus quality.

Localization of the source of sound is regarded chiefly as a function of the cochlea. However it is noteworthy that both factors referred to in the explanation of the localization of sound, intensity and phase, are essentially adequate to stimulate the vestibular apparatus as well, if the mechanical pressure of sound is considered without regard to the specific acoustic quality of frequencies. The explanation so far adopted (Lord Rayleigh, Stevens Davis, *Textbook*) for the localization of the source of sound seems to hold good with regard to the discrimination between right and left, but not between front and behind (Lord Rayleigh). It is suggested that apart from the differentiation of phase between right and left for low tones, and from the differentiation of intensity between right and left for directional estimation of high tones, a third factor might be in operation—the vestibular sensation of sound conducted indirectly through bone i.e. sound entering the head and internal ear in the original direction, not diverted through the external auditory meatus, and arriving

at the vestibular organ (semicircular canals) by so-called indirect bone conduction.

The existence of indirect bone conduction was proved by Mader (*Kaiserl. Acad. Wiss., Wien., Mathem. Naturwissensch. Kl.* 109, iii, 37, 1900). The intensity of sound reaching the *cochlea* by indirect bone conduction is too small to play an essential part in qualitative hearing. However, whether or not the intensity is strong enough to stimulate the *vestibular* apparatus on a small but effective scale, is quite another question.

It is known that extremely small pressure stimuli are accurately discerned by the vestibular organ. As Fischer-Wodak showed in their experiments on exact subjectivism, differences of even less than  $\frac{1}{2}^{\circ}$  C. (using the writer's minimal caloric tests) can be discriminated by the subject under test. Schmaltz (*Vorgänge im Bogengang bei Kalor. Reizung, Pflüger's Archiv.*, ccviii, 424, 1925), in experiments which also employed the minimal caloric tests, has calculated that nystagmus starts when the speed of the endolymph reaches the magnitude of  $1 \cdot 10^{-6}$  cm. per sec. =  $\sqrt{\frac{1}{1.000.000}}$  mm. per sec. =  $\sqrt{\frac{1}{1.000.000}}$   $\mu$  per sec., and when the movements of the endolymph reach the magnitude of  $3 \cdot 10^{-4}$  cm. =  $\frac{1}{30.000}$  mm. =  $\frac{1}{30}$   $\mu$ .

On gross caloric stimulation, however, (1,000 c.c.; 250 c.c./min.) the nystagmus starts only when the speed reaches  $3 \cdot 10^{-4}$  cm./sec. =  $\frac{1}{30.000}$  mm./sec. =  $\frac{1}{30}$   $\mu$  per sec., in which the movement of the endolymph reaches  $1 \cdot 10^{-2}$  cm. =  $\frac{1}{100}$  mm. = 10  $\mu$ .

The vestibular apparatus reacts, therefore, more to minimal pressures than to those of greater magnitude. This may depend on specific conditions in the caloric test ("inhibition" following gross caloric stimuli—author), but it can depend equally well on the fact that the vestibular apparatus is much better adjusted to minimal pressures than to those of greater magnitude. The crucial experiment is needed to find out whether the acoustic pressure of sound waves, arriving at the vestibular organ, falls in the range of those figures which Schmaltz has calculated to be effective.

The classical experiments of Lord Rayleigh suggest that there is a factor in operation which is not solely related to the acoustic function of the *cochlea*:

"With pure tones there was discrimination between right/left, not between front or behind the observer. But with sounds of other character and notably with the speaking voice front and back could often be distinguished."

Possibly, the equal sound intensity of a "pure" tone, estimated only as one, the initial stimulus, produces no effective response in the vestibular organ; however, the constant small variations of the speaking voice do, owing to the numerous subsequent accelerations and retardations elicited in the endolymph of the vestibular organ, and owing to the law of *accumulating vestibular sensitization* by "residual tonus" resulting from vestibular stimuli repeated at short intervals (*vide* infra-vestibular effectivity, Section II (2)).

Consideration of vestibular sensitivity in directional hearing does not allow us to overlook the fact that directional hearing is dependent on the existence of stimulation of cochlear sensitivity. Therefore, directional hearing, though more easily understandable by regarding the components

# Contributions to Functional Pathology of the Ear

of sensitivity, is finally a function of "efficiency". One type of efficiency was defined as being compound of "panaural" functions (*vide* Introductory chapter); efficiency is in the case of directional hearing based on proper co-operation between auditory and vestibular sensitivity.

## II. Efficiency

### 1) HEARING.

As has been said above, there is a basic difference between audiometry and tuning fork tests, in which the customary test is carried out using the uninterrupted decay period, that is the fork is held continuously to the patient's ear from the moment of striking until the fork ceases to be heard. The physiological conditions, however, and so also the threshold figures are quite different when the fork is brought to the ear at intervals, say 3 seconds, during the decay period.

The existence of this basic difference is, and must be, overlooked, when the old customary tuning fork tests are erroneously regarded as a method of recording only the threshold of "sensitivity"; then, tuning fork tests and routine audiometry would indeed be essentially the same. It is, however, of prime significance that the uninterrupted tuning fork test provides, in addition to the threshold of sensitivity, information about the "efficiency" of hearing over a certain period of time in the specific conditions of the decaying tuning fork, i.e. hearing during a period of *diminuendo*. This period depends, as described (*J. Laryng. and Otol.*, lv, 9, 1940) in the steppage tests, not only on the threshold of sensitivity, but also on the power of the initial stroke by which the fork is set in motion. There must be one or more additional factors which inhibit auditory sensitivity, and so diminish the "diminuendo period hearing". Otherwise we could not expect to find in the special steppage tests several thresholds which are interrelated according to a certain law.

The additional factors, so far not definitely established, are suspected to be fatigue in the cochlear nerve and for special responses, fatigue or otherwise, in the tympanic muscles.

The variability of the thresholds in accordance with the varying power of the stroke of the fork are obviously dependent on these additional factors. These conditions, with special regard to the activities of the tympanic muscles, will be more fully explained in the next paper. It should be mentioned here that the first period of the steppage tests corresponds roughly with the period estimated on the usual uninterrupted tuning fork test, the latter provides, therefore, a test rather of the complex function of "efficiency" (of *diminuendo* period hearing) than of "sensitivity", i.e. pure tone threshold sensitivity. The complete estimate of sensitivity is for the most part not shown by the first "threshold" at the end of the first period, but by the ultimate threshold obtained during the last period.

According to the definition of efficiency given in the introductory section, it is justifiable to regard the complex function of "diminuendo

period hearing " of tuning forks as a test of efficiency. Consideration of efficiency is the more justified when complex every day hearing is concerned, or, when, for example, hearing of pure tones is carried out under special conditions, such as the interference of noise, demonstrated in the " provocative test " (*J. Laryng. and Otol.*, 1943, lviii, 1).

The types of auditory efficiency so far described are " panaural " (intracochlear plus extracochlear) in the sense of the definition given above. Two types of purely intracochlear auditory efficiency are " compensation " and " equilibration ", which have both been briefly mentioned previously (*J. Laryng. and Otol.*, lviii, 11).

Compensation is understandable by admitting the musical faculty, to recognize, in a set of fundamental and harmonics (overtones), the specific structure of this set, even when one or a few of the constituents are missing: basic " *structural hearing* " as a part of structural psychology. Structural hearing applies therefore not only to sequences or harmonic composition of tones, but also to single musical tones.

When hearing a musical melody or a spoken sentence, we do not analyse single tones or single vowels and consonants respectively, but we hear a melody or a sentence more or less as a whole, as a " structure " of the constituent elements, without becoming aware of each single element, unless we direct special attention to these single elements for some specific or scientific reasons. What applies to whole melodies and sentences, applies equally well to musical tones, that is when the tones are not pure, i.e. free of overtones, a contingency which practically does not arise in every day hearing. These considerations involve the application of the principles of " structural psychology " to auditory analysis of elementary hearing.

G. F. Stout wrote (1896) in his *Analytical Psychology* that " noetic synthesis owes its peculiarity to the introduction of a mental factor, the apprehension of the whole, which determines the order and connection of the apprehension of parts ". Not only the complicated structure of a melody, but also the more simple structure of a tone, compound of fundamental and harmonic overtones, is still recognizable, when only an essential part of the structure of the tone is available. The individual is obviously able to interpret on the basis of *pars pro toto*, so long as an essential residuum of the normal tonal structure is still existent. This structural substitutional compensation—adaptation to a new structural situation provides an explanation why patients with progressive congenital deafness feel some improvement in hearing, when the progress of this deafness is halted, and so no further change in the tonal structure is occurring, even if a positive improvement of single elements of the structural tone is missing. The " improvement " is interpreted as a psychological one, based on a steady substitutional compensation related to the principles of structural psychology. Hearing is obviously able of

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correct adjustment to a new sensory situation only when there is no permanent change in the structural reciprocity of the elements of hearing

With reference to structural hearing and to the scale of tones which structurally can substitute the one for the other—provided the structure as a whole is reasonably intact—the importance of various frequencies in the tone scale of speech is worth mention. It was first demonstrated in tables by Steinberg and Gardener, later modified by E P Fowler, Sr (1932) quoted by Fowler, Jr (1943). Steinberg and Gardener's figures are

$$\frac{250 \text{ dv}}{2\%} \quad \frac{500 \text{ dv}}{15\%} \quad \frac{1000 \text{ dv}}{20\%} \quad \frac{2000 \text{ dv}}{34\%} \quad \frac{4000 \text{ dv}}{26\%} \quad \frac{8000 \text{ dv}}{3\%} = 100\%$$

*Compensation* it was said (*J Laryng and Otol* 1943 lviii 11) is to be taken into account in an individual organ when a part of it is more or less out of action and the surviving parts adjust to a new functional situation. Compensation is understandable as a psychological shifting of the original percentages of fundamental plus overtones by adjustment to and perseverance in the new functional situation. In relatively rapidly advancing deafness there is no chance of adjustment but in slowly progressive deafness or when the advancing deafness can be halted the ear has a chance to get adjusted and to identify and to differentiate the different timbres in spite of their poorer (proportionally wrong) overtone structure if the structure as a whole has not become too weakened or thrown too grossly out of balance.

*Equilibration* was discussed in Cases 5 11 18 and 22 (the latter in particular) in an earlier paper (*J Laryng and Otol* lviii 11) as the tendency of balancing the hearing power reciprocally between both ears.

*Auditory Combination* is of course situated on a much higher psychological plane but is however dependent on the physiological capabilities of compensation and equilibration.

## (2) VESTIBULAR SENSATION

The association of the efficiency of the cochlear nerve with activities of the tympanic muscles can be assumed, in particular as a result of the provocative tests (1943). The efficiency of the vestibular nerve is closely associated with the eye muscles i.e. vestibular nystagmus. Nystagmus regarded as a test of efficiency is quite reasonable, as the phenomena of vestibular nystagmus are in conformity with those of optical nystagmus, and the latter is certainly a phenomenon of efficiency, of visual adaptability to the absolute or relative movement of surrounding objects.

The association of the vestibular nerve with activities of the tympanic muscles is not proved. But it would be paradoxical to assume that the tympanic muscles are the only ones not sharing in vestibular tonus.

In regard to vestibular efficiency there are three features rather different from what is found in other sensory nerves viz

- (a) vestibular tonus at rest
- (b) residual vestibular tonus after stimulation
- (c) close bilateral interrelation between the vestibular centres

(a) *Vestibular Tonus at Rest.* The vestibular nerve is, as generally acknowledged, in a state of permanent stimulation, even when the body is at rest, in contrast to other sensory organs: positional tonus in the utricle.

(b) *Residual Vestibular Tonus.* Stimulation of the vestibular nerve is followed not by fatigue, but by an increased residual tonus, abnormal tonus in the case of abnormal stimulation, detectable by change of muscular tone, particularly in the external muscles of the eye. This was shown in the writer's first experiments on *Nystagmus-Bereitschaft* or *Nystagmus Susceptibility*\* of dormant Nystagmus (*Beitr. Anat. Physiol. etc. Ohr*, 1918 vol. 10 and 11). For example caloric sub-threshold stimulation, at, say, 30° C. for 5 c.c. in the right ear, produces in a certain case no nystagmus or other muscular response in the eye-muscles. This caloric sub-threshold stimulation is repeated shortly afterwards in the left ear, producing nystagmus. This was explained as, and is still regarded to be due to, a state of *dormant nystagmus* upon vestibular central *residual tonization* remaining from the previous stimulus in the right ear. This residual vestibular tonus was interpreted as "directional neutrality" produced in the right ear by the first stimulus which means nothing more than vestibular *non-directional residual tonization*. I became fully aware, following Hallpike's comment and reference to Bechterew's statements, that this is a supplement to Bechterew-Hallpike's laws: Residual vestibular tonus is related not only to destructive (Bechterew-Hallpike), but also to stimulating changes in the vestibular nerve (author).

This residual vestibular tonization can be elicited and detected not only by calorization, but also by rotation upon sub-threshold stimuli in the following way. The lightly closed eyes of the patient are touched by the second and third fingers of the observer standing behind the patient, as suggested by Grahe. The patient's head is turned successively to the left and right. No nystagmus occurs during the first three or four of these movements in a great number of cases; but not infrequently nystagmus appears after a series of such turning movements of the head. As left/right turning produces an antagonistic effect peripherally in the labyrinth, the effect of sensitization is explained, analogously to the subsequent caloric stimulation right/left, as central tonization by summation of sub-threshold rotatory stimuli, which, peripherally counterbalanced, give rise to labyrinthine directional neutrality.

In view of a *vestibular tonus on movement*, residual vestibular tonization appears to be of special significance in regard to the important movements of the head. It is a physiological law that the eye or ear is directed towards the source of the optical or acoustic stimulus, by rotation of the head, which must involve some stimulation of the canals and consequent residual tonization. The important types of vestibular tonus, associated with hearing or vision, would therefore be elicited by rotatory movements

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\*.The term Nystagmus Susceptibility is suggested by C. S. Suggit.

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of the head, and so, of the canals [It might be worth mention here that changes in the neck muscle tonus of the pigeon follow isolated lesions of the canals (quoted by Hallpike *et al*, 1942)] This vestibular tonization occurs secondarily only to primary optic or acoustic stimuli, whereas primary vestibular tonization is to be taken into account, if perception of directional acoustic stimuli in the vestibuli apparatus is admitted (according to Section I (2b))

(c) *Close bilateral interrelation between the vestibular centres* The old Bechterew laws of vestibular bilateral interrelation were duly taken into account and applied to the phenomenon of unidirectional dormant nystagmus upon unilateral nystagmus susceptibility (called directional preponderance by Hallpike) Unilateral nystagmus susceptibility was in pathological cases more frequently observed than bilateral nystagmus susceptibility, whereas bilateral nystagmus susceptibility was found in the original experiments with bilateral sub-threshold caloric tests which only give rise to the suggestion of a state of nystagmus susceptibility

As said above, the laws of nystagmus susceptibility are based on the law of Residual Vestibular Tonization (*vide* Section II (2b)), which, in general, are valid not only upon vestibular destruction (Bechterew-Hallpike), but also upon vestibular stimulation (author)

## Vestibulo-Cochlear Efficiency

The analysis of directional hearing broached the question, whether some functions of musical hearing are, as a matter of efficiency, dependent on the combination of cochlear and vestibular sensitivities Rhythm, musical accentuation, were mentioned as musical factors possibly in the range of combined cochlear and vestibular sensitivities, and beats as suggestive of some vestibular participation in hearing As sensation of musical disharmony is associated with the occurrence of beats, disharmony might be due to a specific vestibular interference in musical hearing

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II EFFICIENCY—(1) *Hearing*—Tuning fork tests as tests of *diminuendo* period hearing—Speaking voice—Monaural "compensation" in timbre hearing upon structural hearing as a factor of "structural



psychology", in cases of progressive deafness.—Binaural "equilibration."—"Combination."—(2) *Vestibular Sense*.—(a) Vestibular tonus at rest.—(b) "Residual vestibular tonus" as the basis of nystagmus susceptibility (dormant nystagmus).—Vestibular tonus on movement with reference to the turning of the head towards the source of acoustic or optical stimuli.—(c) Bilateral interrelation between the vestibular centres upon residual vestibular tonus.

*Vestibulo-Cochlear Efficiency* and musical hearing.

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I wish to thank the Honorary Staff of the Ear Department of University College Hospital for the opportunity to use their clinical material during the last five years.

## CLINICAL RECORD

### A TRAUMATIC IVORY OSTEOMA IN THE LEFT ETHMOID

By W. STIRK ADAMS (Birmingham)

A HEALTHY boy, aged 13 years, came under the care of my colleague Mr Charles Rudd, on August 25th, 1942, suffering from a left-sided exophthalmos

In the previous January he had received a blow from a snowball in the left orbit, which was followed by bruising and swelling of the left orbital tissues. When the swelling subsided, the left eye was seen to be proptosed and was also pushed outwards in the orbit. There has been no further displacement since it was first noticed. There was much epiphora and on closing the eye it was sore, but apart from this there has been no pain or headache.

Examination showed him able to read a newspaper with either eye. In the right eye the lids were normal, media clear and fundus and disc normal. In the left eye exophthalmos was present without signs of inflammation. The lids closed completely. Fundus and disc were normal.

A small hard fixed nodule was felt at the inner canthus of the left eye. An X-ray report on August 27th showed an osteoma in the left ethmoid. Optic foramina on both sides were normal. Surgical opinion at that time advised against interference in view of the likelihood of extremely slow growth and the absence of complications.

On March 9th, 1943, he was re-examined, and a hard bony mass was palpable on the inner side of his left orbit. Proptosis and lateral displacement of his eyeball had increased and the globe was also pushed slightly downwards. The measurement from the mid-line of his nose to the inner canthus of the eye on the right side was 1.5 cm, and on the left 2 cm. There was no diplopia and no loss of vision.

X-ray examination on March 10th, 1943, showed the osteoma had greatly increased in size and in view of its rapid growth Mr Rudd considered removal should be undertaken before complications supervened.

In consultation with Mr William H Sweet of Harvard, attached to the Queen Elizabeth Hospital as Neuro-Surgeon it was thought that a trans-frontal approach would be unlikely to succeed in more than fragmentary removal, while an anterior approach reflecting the external nose was open to the objection that free access to the posterior part of the tumour, which I regarded as the most likely area of danger, would not be possible. I concluded that the most satisfactory approach lay through the left maxillary antrum, and at Mr Rudd's invitation I undertook removal by this route. The difficulty I foresaw was that the tumour might be densely attached to an inaccessible bony plate such as the horizontal plate of the frontal, and even were there no

such bony attachment, its size might prevent delivery. The main risk I foresaw was of damage to the left optic nerve and of a dural tear in the anterior fossa of the skull, should it be adherent.

At operation on April 6th, 1945, induction was by Ethyl Chloride Ether followed by Chloroform. The intra-tracheal ether anæsthesia was given through a gum elastic catheter passed through the mouth. A sublabial incision extending over the midline, exposed the anterior face of the left maxilla. Removal of a large part of this face showed the tumour presenting into the upper medial angle of the left antrum along its whole length. The medial wall of the maxilla was then removed and part of the attached margin of the left nasal bone. A blunted Freer's curved septal elevator was then passed between the tumour and the orbit. The elevator was then passed between the tumour and the soft tissues anteriorly and then posteriorly. It was then possible to grasp the tumour between the blades of the Dennis Brown adenoid tag forceps, one blade in the nasal cavity, and the other between the tumour and the orbit. Slight lateral mobility of the tumour was detected. The tumour was then further freed from its soft tissue attachment by the elevator anteriorly and posteriorly. Mobility on rocking with forceps was then greater. Further passages of the elevator anteriorly, laterally and posteriorly to the base of the skull ultimately allowed the tumour to be rocked free in its bed, and then the posterior part of the tumour was delivered downwards into the large cavity of access. The posterior part of the tumour was then replaced and the anterior part delivered downwards into the cavity, from which after further removal of the margin of the left nasal bone, it was easily removed. The main difficulty in its release lay in obtaining air entry around the tumour to allow its displacement from the bed in which it was very firmly held by negative pressure. When this had been achieved displacement was easy, and no bone attachment existed.

Inspection of the cavity left by its removal showed an intact oval area of anterior fossa dura approximately  $\frac{3}{4}$  in. in its long diameter. The nasal septum was intact, while on the orbital side of the cavity compressed ethmoidal cells were recognized. Hæmorrhage was at no time troublesome. Antiseptic packing was inserted into the tumour cavity and brought out through the left anterior naris. The sublabial incision was then closed.

Recovery was uneventful, though diplopia was troublesome for the first few days; there was no disturbance of visual acuity and little headache.

The tumour measured 2 in. by  $1\frac{1}{2}$  in. by 1 in. and its surface is roughened especially at its upper anterior pole. Microscopically it is an ivory osteoma, while at one place there is a marked formation of spindle celled tissue which is very vascular. Osteoclasts are present and osteoid tissue of poor quality is being laid down in parts.

The mucous membrane and periosteum from its outer margin show no sign of malignancy.

In the year following removal his progress has been satisfactory and his eye displacement has disappeared. Follow up radiographs have shown no sign of recurrence of the tumour. No radiation therapy has been considered necessary.



FIG 1  
Oblique View of Skull August 27th 1942



FIG 2  
Oblique View of Skull August 27th, 1942



FIG 3  
Lateral View of Skull March 10th 1943



FIG 4  
Antero-Posterior View of Skull March 10th, 1943.

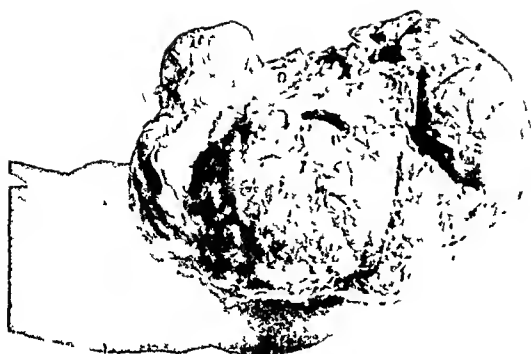


FIG 5

Osteoma after removal    Lateral View    Anterior aspect lies to the left





# Clinical Record

## Comment

When he was first seen the large size and known slow rate of these tumours seemed to exclude the snowball injury as a cause, and the local symptoms were attributed to a minor injury in an area adjacent to a pre-existing tumour. In view of its great increase in size in the short space of eight months I think this view must be revised and I conclude the evidence suggests the tumour had its origin at the initial injury to the outer wall of the left ethmoid.

I would like to express my appreciation to Mr. Charles Rudd for presenting me with this surgical opportunity, and to Mr. William H. Sweet, for his most helpful interest in this case. Also to Professor Haswell Wilson for his opinion on the microscopy.

# A CASE OF ACUTE MASTOIDITIS LABYRINTHITIS AND OTOGENOUS MENINGITIS

By CAPTAIN J. B. SCOTT (R.A.M.C.)

UP to the time of Maxwell Ellis's report (1944), in the literature accessible to me, the treatment recommended for otogenous labyrinthitis with signs of meningitis included labyrinthectomy (Mysel, 1942; Logan Turner, 1932). His case of otitis media, suppurative labyrinthitis and meningitis was treated conservatively with large doses of sulphapyridine.

The case described here was treated before publication of Ellis's report, by simple mastoidectomy, drainage of the dura of middle and posterior cranial fossae, and the labyrinthitis with sulphapyridine.

## Case Report

An R.A.S.C. driver, W.P., aged 28, was admitted to a British Military Hospital in the Middle East on March 22nd, 1944.

He complained of right-sided earache, headache, vomiting and giddiness, of about five days duration, following a common cold. The headache was frontal and severe; the giddiness had started on the previous evening, though he had been vomiting everything he took by mouth for 48 hours. He did not complain of pain in the mastoid region or temple. Cerebration was slow, but he gave clear replies to questions. There had been a left-sided aural discharge and deafness for two years, the cause of which he did not know.

*On examination.*—Temperature, 100.4; pulse, 62. Pale, sweating, lying on left side. Facial weakness (R) of lower motor neurone type.

*Right ear.*—Profuse pulsating muco-purulent discharge. R.M.T. red and oedematous; anterior central perforation. Fistula test not done. Mastoid outlines partly obliterated by periosteal oedema. Tenderness not marked. Hearing apparently nil.

*Left ear.*—Large posterior inferior marginal perforation, with few granulations, bathed in a little stale muco-pus; not pulsating. Hearing: C.V. 2 feet. Nystagmus, coarse irregular 1st degree, to left. Diplopia on looking to left; vision otherwise normal. Discs and fundi normal.

Neck stiff and unable to flex, Kernig's test negative; knee jerks: R, normal, L, increased; Plantar reflex: R, flexor, L, extensor. W.B.C., total 13,800. Polymorphs, 71; Lymphocytes, 24; Monocytes, 4; Eosinophils, 1.

## Treatment

Sulphapyridine course initiated immediately; 4 grammes by mouth which he did not vomit.

Lumbar puncture: Pressure increased; clear fluid, cells 375 c.mm.; polymorphs, 78; lymphocytes, 22 per cent. No organisms seen, culture sterile.

# Clinical Record

*Operation*—Pentothal followed by intratracheal ether R, cortical mastoidectomy Pus found early in operation field (Culture, H Strep) Granulations in antrum No macroscopic lesion seen in external semi circular canal Sinus and dura of posterior cranial fossa exposed—normal Dura of middle fossa exposed widely—inflamed, dark red no pus Dusted with sulphonamide powder, loose saline dressing Two S W G stitches to upper extremity of wound

## Progress

For nine hours after operation sulphapyridine was given in intravenous saline 1 gramme three hourly, and thereafter by mouth The signs of meningitis cleared completely in seven days

A sulphapyridine rash necessitated stopping the drug at 39 grammes total

Within three weeks the facial weakness and nystagmus passed off, the left knee and ankle jerks were still slightly increased, and the left plantar reflex equivocal, R M T dry perforation, and mastoid wound granulating up

Secondary suture was done on 33rd day, following which the otitis media flared up pulsating discharge in the meatus and wound area from which H Strep were grown continued till 55th day when the wound was explored under continuous Pentothal anaesthesia, unhealthy granulations were cleared out, a small zygomatic cell ablated, and posterior meatal wall lowered a little As sulphonamide skin patch tests were negative a 30 gramme course was given without untoward reaction

By 120th day the wound and R M T were healed, R, hearing nil (Ac and Bc), Caloric test L, normal, R, no response Rotation test slight response of 10 seconds' duration after turning in counter-clockwise direction, C N S normal Lumbar Puncture pressure 120 mm, cells under per 2 c mm, protein 40 mgr

The left ear had dried up with frequent syringing clean, and insufflations of 1 per cent Iodine in Boric Powder, leaving a severe degree of deafness due to secondary otosclerosis

Otherwise he was fit and later invalided to U K

## Discussion

I have reported the case as it is an uncommon condition, and more conservatively treated than taught in the past

This case differs from Maxwell Ellis's (1944) in that the acute mastoiditis required operation

During the simple mastoid operation it is comparatively easy to drain the dura as recommended in the pre sulphonamide days Having done this, may not the labyrinthitis be regarded as if it were uncomplicated, and treated conservatively with the modern reinforcement of sulphapyridine, or better still sulphadiazine? If so the advantages are a shorter, easier operation, with less danger to the patient who is gravely ill, and to his facial nerve The satisfactory recovery in this case supports the argument

# J. B. Scott

## Summary

A case of acute mastoiditis, acute diffuse purulent labyrinthitis and otogenous meningitis is reported.

The treatment consisted of simple mastoidectomy, drainage of the dura of middle and posterior fossae, and a 39 gramme sulphapyridine course. Labyrinthectomy was not done.

It is suggested that labyrinthectomy may not be necessary in similar cases.

My thanks are due to the Director of Medical Services, Middle East Forces, for permission to publish this case.

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## CLINICAL NOTE

### A NOTE ON THE USE OF ZINC PEROXIDE IN OTOLGY

By COLIN M JOHNSTON (Epsom)

A PAPER by Hoyle, C, Spence, J W, and Faulkner, S H (*Lancet*, 1942, 1, 7) on the pharmacology and preparation of zinc peroxide, and reports of its properties by surgeons of the Chest Unit at Horton Emergency Hospital, have led to its trial in certain ear conditions. It was reported to be non irritating to tissues, to stimulate the growth of granulation tissue, and to exert inhibitory action on the growth of many organisms. These observations have been confirmed in its trial in ear conditions.

Of the preparations described by Hoyle *et al*, the 10 per cent. oily emulsion (zinc peroxide 10, glycerol monostearate 3, nut oil to 100, all by weight) was chosen for trial as the consistency allowed of easy application on ribbon gauze into the ear.

Although employed successfully for other conditions, zinc peroxide has proved of most value in the treatment of certain types of otitis externa, and following mastoid operations where other antiseptics cause local irritation.

*Otitis Externa* When a long-standing infection has caused chronic œdema with partial or complete occlusion of the meatus, removal of discharge and debris from the depths of the meatus is difficult or impossible until patency can be restored. Direct pressure on the œdematous area will reduce swelling, and can best be applied by packing the meatus with  $\frac{1}{2}$  inch ribbon gauze usually impregnated with some antiseptic to inhibit bacterial growth. No preparation previously tried could be relied upon to be non irritating in all cases but during the past two years the use of zinc peroxide emulsion has never been found to produce irritation. The meatus was tightly packed under direct vision through a speculum every day or on alternate days. Apart from deafness resulting through occlusion of the meatus, no patient complained of discomfort, and pain previously present was usually relieved. After two to four days, the meatus was found to be widely dilated, often to the normal size, and any offensive odour previously present had disappeared. If the packing was left out at this stage, however, the œdema would usually recur in a few hours, and treatment was continued for a total of seven to ten days. After this time the more recent case required no further treatment, but the more resistant case reacted better to other forms of treatment as indicated by the judgment of the surgeon.

In short, packing the meatus with gauze impregnated with zinc peroxide emulsion has been found to restore patency in a few days, allowing free drainage and certain application of medicaments subsequently used. Further, in no case has irritation been observed from the procedure.

## Colin M. Johnston

*Mastoidectomy Dressing.* Following the radical operation, and in many cases the cortical operation, some form of packing is inserted into the cavity made in the temporal bone. Iodoform applied on gauze may be used as an antiseptic, and trial of other antiseptics has not found any other substance which exerts a positive antiseptic action over a prolonged period without causing injury or irritation of bone or soft tissue. A prolonged action, avoiding the necessity of changing the packing, will reduce the frequency of painful dressings or the use of general anæsthesia, and is one of the desirable properties of iodoform. Unfortunately, however, in a few cases, iodoform will cause severe dermatitis of the skin round the wound or of the meatus or pinna. Such cases are frequently associated with a previous chronic otitis externa. When such a condition arises, other antiseptics such as eusol or perchloride of mercury may not reduce the inflammation in a short time. If in such a case any iodoform remaining in the wound after removal of the packing was cleared out as carefully as possible by swabbing, the cavity then being packed with gauze impregnated with zinc peroxide emulsion, it was found that subsidence of the dermatitis occurred in all cases within a few days. Owing to the limited time that the peroxide remained active in contact with the tissues, it was found necessary to change the packing every two, or at the most, three days, otherwise pus formation and an offensive smell would develop.

My thanks are due to Dr. Nicol, Medical Superintendent, Horton Emergency Hospital, Epsom, and to Mr. Negus for his encouragement and permission to experiment with this preparation on cases under his care in this hospital.

*Note.*—Commercial zinc peroxide as obtained in this country contains in addition the oxide, hydroxide, and carbonate as impurities in diverse amounts. The preparation used in these trials contained 38% to 40% of peroxide.

*Preparation.* Sterilize the nut oil by heating for an hour at 150° C. in a hot-air oven. Cool to normal temperature. Add the glyceryl monostearate to the nut oil. Heat both to 130° C. for an hour. Cool to normal temperature. Incorporate the zinc peroxide with the nut oil and monostearate in a sterile mortar under aseptic conditions, sifting the zinc peroxide through sterile muslin. Store in sterile glass-stoppered bottles, capping with sterile parchment paper.

# SOCIETIES' PROCEEDINGS

## ROYAL SOCIETY OF MEDICINE—SECTION OF LARYNGOLOGY

May 5th, 1944

*President*—W. M. MOLLISON, M Ch

### Discussion on Lymphoid Diseases of Upper Respiratory Tract

A H T ROBB SMITH

THERE is a large amount of lymphoid tissue in the upper respiratory tract, and all of it is of the lympho epithelial type, that is to say it has only efferent lymphatics and the mucous surface is covered by epithelium of a peculiar type, having no basement membrane, with the result that the two types of cell merge in the boundary zone. Apart from this, the morphology of the lymphoid portions is in no way different cytologically or anatomically from lymph nodes, being divisible into follicles, sinus and medulla with a variety of cell types of variable potencies. In connective tissues throughout the body, and this applies with equal force to the connective tissue of the upper respiratory tract, there are inconspicuous mesenchymal cells which have retained their embryonic potencies in the adult organism and may, under suitable stimuli, differentiate to form any type of cell within their potency so that new formed areas of lymphoid tissue may appear as the result of such stimuli. The disorders of the lymphoid tissue of any region of the body must be divided into two categories (a) those initiated by local conditions limited to that region, (b) those in which there is a generalized abnormality of the lymphoid tissue throughout the body and, therefore, the lymphoid tissue of the special region undergoes a similar process. It may be from a clinical point of view, that the regional involvement is the presenting symptom of a generalized lymphoid disorder but that in no way justifies its isolation from the point of view of nosography.

In either category the change in the lymphoid tissue may be reactive, that is to say the result of stimuli of which we have some knowledge, or idiopathic, in which we have at the present no real knowledge of aetiology, though we may know much about the morphogenesis of the condition.

The term "*reticulosis*" has become unduly popular as it sounds impressive even if its meaning is not understood. Reticulosis was coined some fourteen years ago as a generic morphological term in pathology to describe hyperplastic conditions of the reticular tissue, and embraces the leukaemias, Hodgkin's disease and kindred idiopathic conditions, and, from a reactive point of view, the morphological changes occurring in the tissues in tuberculosis and typhoid fever,



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reticulosarcoma is its neoplastic counterpart. It is comparable with other generic terms such as arthritis, neuritis, or catarrh though it is used more strictly in a morphological sense; to say that a patient has "a touch of reticulosis" means no more than to say that a patient has lymphoid hyperplasia. On the other hand when suitably qualified it indicates the particular type of hyperplasia, thus Hodgkin's disease or lymphadenoma verum may be described as fibromyeloid medullary reticulosis, or leukæmia as "myeloid or lymphoid medullary reticulosis", but the commonly used terms are preferable as they are shorter and, provided they are used strictly on the basis of good clinical or pathological criteria, just as acceptable to the systematist. However, a critical study of pathological conditions formerly grouped under the two headings of atypical Hodgkin's disease or pseudo-leukæmia has made possible the recognition of conditions with a definite natural history and morphology. As these have at present no clinical names it is necessary to use morphological descriptive terms based on histological criteria. These terms are cumbersome for the lack of a satisfactory shorthand such as chemists use. Thus we may have to say that a patient is suffering from lymphoid follicular reticulosis or lympho-reticular medullary reticulosis but such ponderosities should mean something quite definite, both clinically and pathologically. However, the vast majority of locally limited processes are either reactive or neoplastic.

In the lymphoid hyperplasia that may occur in association with chronic inflammatory conditions of the nasopharynx the agent may be microbic; in other cases it is not so easy to identify any convincing causal organism and in these the character of the process may be somewhat bizarre but is essentially self-limiting.

I shall leave the neoplastic conditions as they do not truly come within the ambit of our discussion and consider those in which the nasopharyngeal lymphoid tissue has undergone hyperplasia as a result of a generalized process.

*In the reactive group the most familiar example is measles, where a prodromal hyperplasia of a characteristic type affects lymphoid tissue throughout the body so that on occasions the pathologist examining a tonsil or appendix can tell the surgeon that the patient will develop measles before the rash has appeared; the same applies to a number of other infective diseases. Turning to the idiopathic group, the changes in leukæmia are illustrated by the firm nodular masses found in chronic lymphatic leukæmia and the swollen, often ulcerated, tonsils of acute leukæmia, often the first sign of the disease.*

In the group without gross blood changes the nasopharyngeal tissue may be involved. I will recount two cases. A man aged about 50 complained of a rapid unilateral tonsillar enlargement and his doctor removed the tonsils; three years later enlarged glands appeared in the neck and a biopsy revealed one of the more benign types of primary lymphadenopathy—lymphoid follicular reticulosis. A section of the tonsils which had been kept in spirit showed the same changes as the lymphoid nodes. Although lymphoid follicular reticulosis is relatively benign it can and does cause death in a few years unless general radiotherapy is given. Another patient who had another type of lymphadenopathy, again relatively benign, but with a liability to appear in different sites at irregular intervals had been under observation for some years when he suddenly developed tonsillar enlargement. On removal, their histology was

identical with the axillary nodes removed some four years previously. The case of Hodgkin's disease which is being shown to-day is of particular interest for it is my experience that involvement of the nasopharynx in this disease is rare and a survival for ten years in a case of true Hodgkin's disease is also uncommon. In a large series of cases 50 per cent were dead in eighteen months irrespective of treatment and only 5 per cent survived three years. In this case the original lymph node biopsy was not available but the diagnosis had been made by an experienced pathologist, the morphology of the laryngeal biopsy was such that although one would not make a positive diagnosis of Hodgkin's disease yet the appearances were in keeping with such a diagnosis.

I should like to say something of sarcoidosis of which two examples are being shown. The history of the condition is a perfect example of the dangers of over specialization. At the latter part of the last century Jonathan Hutchinson described some curious cases of skin lesions sometimes associated with swollen fingers, which he named Mabey's malady after the first patient who suffered therefrom—a form of eponym all too seldom used. Subsequently Boeck and others described a group of skin lesions variously known as Boeck's sarcoid or lupus pernio.

Pathologists recognized a curious change in lymphoid nodes known as hyperplastic or endothelial tuberculosis in which there was no tendency to caseation and in which acid fast bacilli would not be found. Then at the beginning of this century some other syndromes were recognized, ophthalmologists described a curious association of iridocyclitis with parotitis—Heerfordt's syndrome, and radiologists a cystic change in the fingers—osteitis multiplex cystica or Jungling's disease, and physicians the condition of chronic or benign miliary tuberculosis. It was not until 1914 that Schaumann suggested that these were all facets of the same disease, but partly because the war ensued and partly because he was misguided enough to suggest that the conditions should be called after himself or lymphogranuloma benigna, little attention was paid to his observations and it was not until 1930, as the result of the writing of Pautrier and Longcope that the unity of sarcoidosis was recognized. It is a curious malady essentially benign, protean in its manifestations, uniform in its histology which resembles the tuberculous granuloma in many respects. It has other bizarre affinities with tuberculosis for many of the lesions resemble those seen in lupus save that it does not cause the ulceration and scarring though it may be extremely disfiguring. In contrast to lupus the Mantoux reaction is negative and there are other features which enable a definite diagnosis and prognosis to be made. Its nature is in dispute, but my own feeling is that it is an unusual reaction to acid-fast bacilli of low virulence.

In conclusion I want to re-emphasize that in a lymphoid hyperplasia of the nasopharynx it is necessary to determine whether it is a local reactive condition in which the treatment is that appropriate to the causative factors, or whether it is part of a generalized lymphoid hyperplasia, even where the nasopharyngeal symptom is the primary manifestation, the treatment is then that of the general disease and a local eradication is no justification for assuming a cure.

V E NEGUS (*Chronic hyperplasia of the pharynx, 5 cases*). In 1901, Dr A. Brown Kelly described a case of "Sclerotic Hyperplasia of the Pharynx and Nasopharynx" (*Lancet*, April 6th, 1901).

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The patient had nasal obstruction and suffered from choking fits. The uvula was enlarged, pale, fibrous, and firm; movable, firm prominent bands of greyish colour were present on either side of the posterior pharyngeal wall, passing up into the nasopharynx and down to the upper end of the oesophagus and overhanging the arytenoid regions. Sections from the uvula showed chronic hyperplasia of the interstitial tissues, with no tendency towards degeneration and with no appearance of any specific micro-organisms. The condition was unchanged 14 years later.

Sir Felix Semon described in 1902 "a case of obscure lardaceous-looking variable infiltration of the uvula, soft palate and right arytenoid cartilage in a lady aged 30". It was similar to Dr. Brown Kelly's description (*Proc. Laryng. Soc., Lond., 1902-3, x, 11*). The patient had occasional difficulty in swallowing. Semon also referred to other cases (*Lancet*, February 25th, 1905); one showing involvement of the larynx, there being oedematous infiltration of the arytenoids.

A report on sections by Professor Shattock referred to the intact and normal state of the investing epithelium, the increase in size of the tissues being due to a diffuse formation of finely fibrillar connective tissue, in the central part of which there occurred small groups of fat cells. There were denser collections of cells bearing an obvious relation to the smaller blood-vessels, mainly at the periphery of the section. The cells consisted of lymphocytes and intermingled plasma cells; no mast cells or eosinophils were present in the section. There was a mesh of fine elastic fibrils pervading the connective tissue. Some capillaries a short way beneath the epithelium were plugged as a result of endothelial proliferation. No micro-organisms were demonstrated.

There were none of the structural features of tuberculosis, syphilis or rhinoscleroma nor of neuro-fibromatous pachyderma. A lymphangiomatous and lymphangiectatic lesion was excluded.

"The histological changes approach most nearly to those met with in hyperplastic rhinitis in its later, or what has been called its secondary stage."

Dr. A. Logan Turner described similar cases in 1914, one requiring tracheotomy; in one the bands on the lateral wall of the pharynx disappeared ten years from the date of first observation. Sections showed infiltration with small cells, mainly mononuclears. A further case was reported by Sir James Dundas-Grant (*Proc. Laryng. Soc., Lond., 1902-3, x, 76*).

In 1940 I saw a patient with Mr. Hope, the signs and symptoms corresponding to those mentioned above. Sections from our case were reported to show giant histiocytic sinus reticulosis or possibly sarcoidosis. Three other cases have been seen by me since that date and possibly a fourth, all similar as regards symptoms and clinical appearances; Case 4 has developed a somewhat inflammatory appearance since her first examination, but otherwise the condition has appeared indolent. There have been spontaneous local changes but treatment with deep X-ray therapy and with vitamins has had little obvious effect.

A fifth case, differing in appearance, is included as it was diagnosed microscopically as Boeck's sarcoidosis.

In his description of the reticuloses Robb-Smith includes in the follicular group a lymphoid and histiocytic type, to which it appears these cases may

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belong He gives to this condition the title also of reactive follicular hyperplasia and germinal hyperplasia and describes the condition as occurring most commonly in lymph nodes draining sites of pyogenic infection It would seem, therefore, that there may be an inflammatory cause for the hyperplasia, distinguishing it from other neoplastic conditions

As the several cases described by Brown Kelly, Semon, Logan Turner and Dundas-Grant appear to be clinically similar to those seen by us, it is inferred that they have similar causation, whether it be Boeck's sarcoidosis or histiocytic reticulosis

Their description under the heading of chronic hyperplasia of the pharynx and larynx is of course, too vague, as it gives no account of what elements are hyperplastic or for what reason

The diagnosis of Boeck's sarcoidosis made by microscopical examination is not confirmed by clinical appearances or by radiography of the chest, except in Case 5, where there were shadows, possibly due to the disease

A report of the five cases is appended, but it is to be noted that Case 5 is included merely for comparison, as there were considerable clinical differences from the remainder and also from those described by Brown Kelly, Semon, Logan Turner and Dundas Grant

(1) E G, female, aged 55.

16 1 40 Sore throat and dysphagia one month with some obstruction of breathing Tonsils removed in 1913 Patient is diabetic Swelling of uvula and soft palate without ulceration, considerable oedematous swelling of the epiglottis, left aryepiglottic fold and slightly less on right side, with no involvement of cords Left tonsillar region enlarged and oedematous mass, firm and smooth No evidence of pulmonary tuberculosis or of other changes in the lung fields Wassermann negative There was no rhinitis and no infection in the nasopharynx

Biopsy 9 8 40 "The tonsil is covered by well formed squamous epithelium and the crypts are small Scattered through the lymphoid tissue are small collections of endothelial cells mostly very clearly demarcated In some of these areas are giant cells with numerous nuclei Many plasma cells can be seen throughout the tonsil While it is possible that the condition is an atypical tuberculosis, no tubercle bacilli could be found, there is no caseation, the arrangement of the endothelial cells and giant cells is not of the usual tuberculous type, and the giant cells are not typical tuberculous giant cells, the foci of endothelial cells appear to be for the most part coincident with the sinuses These appearances suggest that the condition may be a giant cell histiocytic sinus reticulosis or possibly a sarcoidosis" Dr Robb-Smith considered the condition to be comparable to those described as lympho-histiocytic reticulosis

She was given deep X-ray therapy at the Middlesex Hospital, but with little change in the laryngeal condition, although the hyperplasia in the pharynx almost disappeared Last seen in February, 1944, with infiltration in the epilaryngeal region

She also had treatment with ascorbic acid 50 mg. t d s

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(2) A.B., male, aged 11.

23.7.40: He suffered from stridor at night, but nothing else. Bigger than his age physically but younger mentally. A previous report was that there was a hæmangio-endothelioma of low malignancy on the left side of the epiglottis.

Direct examination showed diffuse hypertrophy of the epiglottis and aryepiglottic folds, smooth, pale and more marked on the right side, where there were one or two protuberances; there was no ulceration. The vocal cords were overhung by the aryepiglottic folds but otherwise unaffected.

X-rays and blood examination showed no abnormal changes and nothing suggestive of pituitary abnormality.

Sections were previously reported as showing a lymphangioma with some obstruction or a granuloma with development of lymphatics.

Dr. Lloyd reports: "The section shows laryngeal epidermis and the tissues beneath. The epidermis is natural, except where it had been rubbed off. In the tissue beneath, the lymphatics are dilated and contain lymph and lymphocytes. Two or three of those shown in the section also contain aggregates of histiocytes mixed with lymphocytes. There are small and larger foci of chronic inflammatory cellular infiltration, consisting chiefly of lymphocytes but also of plasma cells, among which can be seen multinucleate forms. These aggregates are often related in their position to the abnormal lymphatics, sometimes to blood-vessels. There is no obvious increase of collagen, and no fibroblastic activity. The appearances are those of a chronic inflammation of no specific kind, and do not suggest neoplasia."

(3) D.M., male, aged 23.

In January, 1942, this patient was under the care of Mr. Oxley, suffering from dyspnoea, so marked that sleep was interrupted; the cause was mainly enlargement of the soft palate and uvula, and to a lesser degree, infiltration of the epiglottis and aryepiglottic folds. There was also pale swelling of the posterior pharyngeal walls on either side.

The former condition improved spontaneously and the latter was relieved to a certain extent by deep X-ray therapy. In October, 1942, the symptoms of laryngeal obstruction became worse after a cold; there was some difficulty in swallowing and signs of Eustachian obstruction.

There was no obvious infection of nose, sinuses or teeth. Treatment with ascorbic acid and other vitamins was given, although tests showed no deficiency.

The pathological report on tissue from the pharynx was in favour of Boeck's sarcoidosis: "I am by no means satisfied that the condition is one of tuberculosis. The epithelium is comparatively intact and in the connective tissue there are circumscribed small epithelioid granulomata, none of which are confluent or show caseation. There are some reticulin fibrils running between them and the giant cell forms are very variable, some being large and more suggestive of foreign-body type. There is no doubly refractile material and I have not been able to demonstrate any acid-fast bacilli. . . . this case is more suggestive of a miliary lupoid than anything else, and the history would to some extent support that." A. H. T. Robb-Smith.

(4) A.L., female, aged 56, complained of difficulty in swallowing for five weeks when first seen on 4.2.44; there was hoarseness at the onset. Relatives

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said the disability had been present for eighteen months. The dysphagia has now improved slightly.

The appearances which have changed little, were of two smooth, pale columns on each side of the posterior pharyngeal wall, separated by a deep groove, extending up into the nasopharynx and down to overhang the aryepiglottic folds, the latter were much enlarged, especially the left. The epiglottis and vocal cords were unaffected.

There was no glossitis, no infection in the nose, sinuses or tonsils.

Direct examination showed obstruction of the mouth of the oesophagus by smooth surfaced infiltration.

It was thought that there might be malignant changes, even though no ulceration was present, but biopsy revealed chronic inflammatory infiltration only.

A biopsy from the left pharyngeal column showed the epidermis to be intact and natural in appearance, according to a report by Dr Lloyd.

"Beneath, there is a moderate amount of lymphoid tissue showing germinal centres. These show some evidence of reactive hyperplasia and contain in addition to lymphocytes, many reticulum cells.

The remainder of the subepithelial tissue shows evidence of chronic inflammation and fibrosis with no specific features. The fibrosis is fairly marked and does not appear to be of very long standing, as the collagen fibrils are still delicate and the fibrocytes have plump, often cuneiform nuclei. There is slight dilatation of many lymphatics and in their neighbourhood and in that of the capillaries (which are only slightly congested) there is a chronic inflammatory cellular infiltration in which plasma cells are prominent.

Conclusion Subepithelial chronic inflammatory hyperplasia with fibrosis."

Blood count showed no anaemia or leucopenia. of 7,600 white cells there were polys 59%, lymphos 30%, eosinos 2%, monos 9%.

The patient has been treated with vitamins A, B, C and D, and there is slight improvement in swallowing but some increase of inflammatory appearances in the previously pale aryepiglottic folds.

(5) Male, aged 25. *Boeck's sarcoid affecting palate and epiglottis*—While in hospital for conjunctivitis, infiltration of the palate was noticed on examination, no symptoms were present. One brother had suffered from pulmonary tuberculosis, but the patient had no previous medical history of note.

Raised nodules were present on the hard palate and similar deposits on the free margin of the epiglottis. The latter appeared shrunken and the laryngeal border showed slight ulceration. There were no similar deposits in the nose, and the condition had not the typical appearance of lupus.

Wassermann test negative. Mantoux 1/10,000 negative. 1/1,000 positive.

Blood-count Hb 92% CI 0.95%, RBC 4,800,000 WBC 7,200, polys 58.0%, lymphos 32.0%, monos 6.0%, eosinos 2.4%, basos, 1.6%.

Blood serum Calcium 9.5 mg/100 cc phosphorus 4.4 mg, phosphatase 12.5 units, proteins 7 g, albumin 4.6 g globulin 2.4 g.

X ray examination. Apical scars are present in both lungs. Increased shadowing in right upper and mid zones.

Report on section *Boeck's sarcoid*. Sections show some hypertrophy and slight chronic inflammation without ulceration of the overlying squamous

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epithelium. The dermis is infiltrated by a number of discrete, well-defined miliary lupoid nodules, consisting of a collection of epithelioid cells and giant cells of the Langhans' type, with some lymphocytes. Some of the giant cells show hæmatoxyphil bodies in their cytoplasm. These granulomata differ from tuberculous nodules in certain particulars: they are not confluent; there is very little central necrosis and no caseation. There is little inflammation around them, and there seems to be quiet collagen formation in relation to their edges; there is no ulceration and a Ziehl-Neelsen stain shows no tubercle bacilli.

Lt.-Col. NORTON CANFIELD, U.S.A.M.C. (*Laryngeal obstruction probably due to Hodgkin's Disease*): R.R., a 28-year-old soldier, was first seen April 3rd, 1943, with a chief complaint of hoarseness. The present illness had existed for two months following a mild upper respiratory infection of which the hoarseness was thought to be a complication.

*Past history.*—Not significant except for one attack of axillary glandular swelling twelve years before which was diagnosed Hodgkin's disease and treated by X-radiation. Cure was considered satisfactory enough to be no deterrent for army induction. Otherwise the soldier had been healthy.

*On examination.*—A spare cachectic male adult with marked dysphonia and a wheezing respiration. There was telangiectasis in right axilla at the site of previous X-ray therapy. There was a small herpetic ulcer on the left anterior tonsillar pillar. The larynx was markedly obstructed by a proliferating granulomatous mass on both vocal cords and extending into the vestibule and the subglottic region. The mucosa was ulcerated on the right side. The airway was constricted by the mass to about one-fourth of its normal size. The larynx was easily cocaineized and biopsy was taken by the indirect method. Microscopic examination revealed a process involving the lymphoid tissue and was named Hodgkin's disease by some pathologists. Those of our army hospital and Dr. A. H. T. Robb-Smith agreed on this diagnosis, but others, including the pathologist of the Middlesex Hospital and the Surgeon General's Office in the U.S.A. did not.

By the kind co-operation of Professor Windeyer at the Middlesex Hospital, X-radiation was administered. It was necessary to perform a tracheotomy which the patient tolerated well.

April 29th: After 200 r units of radiation the larynx was much better. The airway had opened. Gradually the larynx returned to its normal condition. The voice improved and by June 20th there was no more evidence of the laryngeal lesion. Total tumour dose 2,490 r.

The patient's general condition improved at first, but later deteriorated. Ulcerations of the skin appeared and were considered manifestations of Hodgkin's disease. He was returned to the U.S.A. June 15th, and word from our Surgeon General was that he was discharged to our Veterans' Administration in poor health about July 15th. A microscopic section of the larynx is presented, and probably represents the type of case referred to by Mr. Victor Negus as reticulosis.

IAN G. ROBIN (*Three cases of frontal sinusitis*): These three ordinary cases demonstrate the still unsatisfactory treatment in most hands of chronic frontal sinusitis.

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The first two patients had been operated on previously at other hospitals but in the third case he thought he had done a complete primary operation, and was much chastened to find cells full of chronic granulations at a second operation

The first patient had had several operations on the right side both external and internal For the last year headaches had been diagnosed as functional There was periodic swelling of eyebrow Operation showed thick granulation tissue in three small recesses far back over orbit There was also a small extradural abscess with about 1 c.c. of pus Complete obliteration of whole sinus was performed and a tube left in the fronto nasal duct for seven days There had been complete relief of headaches for over twelve months

The second case was one of bilateral frontal sinusitis secondary to long-standing pansinusitis There had been multiple operations at various hospitals Severe headaches were diagnosed on occasion as functional X-rays demonstrated frontal sinus cells above orbit Operation on right side three months ago showed pus under pressure in small extradural abscess above orbit, and two cells just anterior to optic foramen full of thickened granulations Complete relief of headaches on right side followed operation

In the third case there was persistent right frontal sinusitis following bilateral Caldwell-Luc operation and bifrontal ethmoidal operation in January, 1943 for long standing pansinusitis At recent exploration of right frontal sinus three cells were found, far back over the right orbit, full of chronic granulations

Operations on the first two cases are contemplated to fill in the eyebrow depressions with pieces of iliac crest bone

Lt Col NORTON CANFIELD said that these cases were also of interest to neurosurgeons Recently he had been told by Col R G Spurling, Neurosurgical Consultant, U S A M C, who had had considerable experience in these severe sinus cases, that a different sort of operative technique was being evolved, one which required a large incision and a tantalum implant to fill the skull defect It seemed that they could take away as much bone as they wished, and that the cosmetic result afterwards, if not satisfactory to the patient, could be repaired by the use of tantalum

F C W CAPPS (*Herniation of pharyngeal wall, two cases*) Male, aged 20, first seen in June 1942 The history was a swelling first noticed under angle of jaw on right side, when aged 6 When aged 10 was "kicked" and swelling became more prominent For three years it had been increasing in size It did not cause any real disability On examination in June, 1942 a swelling over 2 in. in diameter could be produced below right angle of jaw on swallowing or could be inflated by patient There was no definite outline no fluctuation, no regurgitation into pharynx on pressure, and nothing could be seen on indirect examination of larynx and hypopharynx X-rays with opaque swallow showed no definite pouch or outline Opinions are sought as to whether any operative procedure should be adopted Since first seen it has further increased in size

Male, aged 55 He first noticed swelling which appeared low down on right side of neck on coughing Four months later both sides swelled On coughing or inflating the pharynx a swelling appeared under and lateral to lower third of right sternomastoid and under the lower third of the left These were resonant and coughing was caused on forcible collapse Barium swallow showed



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no abnormality. The coughing seems more likely to relate to the lung than to the pharyngeal wall.

The PRESIDENT said that he did not think either of these cases was herniation of the pharyngeal wall. He thought the first case a lymphangioma of the floor of the mouth, and the second, herniation of the apex of the lung.

J. C. HOGG suggested with regard to the first case that a needle exploration should be made.

Brigadier M. L. FORMBY said that he saw a similar case in 1929. The diagnosis then was aerocoele, the swelling was tympanitic but the entrance into the pharynx or larynx could not be discovered. The swelling in the first case seemed dull on percussion.

C. A. HUTCHINSON said that it was not uncommon to see a similar appearance to that shown in the second case among young Scotsmen learning to play the pipes. Their lower necks became distended to a considerable degree while playing, and the condition was certainly of apical pulmonary origin, not pharyngeal. The condition was quite harmless.

T. RITCHIE RODGER (*Section of tracheal tumour*): The symptoms in this case were dyspnoea, stridor, and hoarseness. Indirect laryngoscopy showed a tumour as large as a gooseberry just below the cords, its upper edge preventing complete approximation on phonation. The appearance was suggestive of fibroma. On March 23rd, 1944, operation by extended laryngofissure was carried out. The tumour was stripped off the mucoperichondrium of the posterior wall of the trachea, leaving a smooth surface without any suggestion of infiltration.

Pathological report by Professor M. J. Stewart, Leeds University to Dr. W. J. Purdy, of Beverley: "I concur in your view that this is a malignant tumour, but I think that it is at least in part of epidermoid type and the calcification is taking place in partially keratinized material rather than in secretion. Some of the spaces may be glandular lumina but there is a great deal of solid epithelium of distinctly epidermoid type. I form the impression that it is not very highly malignant, but it is a carcinoma."

Mr. Ritchie Rodger mentioned a companion case which Mr. J. H. Cobb of Sheffield had asked him to show. In clinical appearance it was almost identical with his own case. The operation in both cases was by extended laryngofissure. Mr. Cobb had sent the specimen and radiograph with his notes: "Case first seen on October 29th, 1942. For more than twelve months had been troubled with dyspnoea on exertion and 'weakness' of voice. Examination of the larynx showed the vocal cords to be normal and fully mobile. Below the left cord was a smooth rounded tumour which encroached on the subglottic space. It was pale and suggested the appearance of a chondroma. The X-rays (tomograph) showed a tumour which occupied more than two-thirds of the subglottic region; there was no sign of infiltration of the thyroid cartilage. On November 27th, 1942, laryngofissure was performed and the tumour was removed complete and without difficulty.

Pathologist's report (Dr. Hermitte): The section shows the structure of a myxochondroma which at one part shows definite ossification. It appears benign, but myxomatous change in tumours is frequently suspicious. On the one hand ossification is probably a good sign.

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Dyspnœa disappeared immediately after the operation and the voice became strong and normal after a few weeks. She has remained well.

C A HUTCHINSON (*Primary malignant subglottic tumour of trachea*) Sub epithelial, no surface ulceration, involving the anterior and anterolateral aspects, and extending some 1 in downwards. No evidence of any primary growth in any other organ.

Death occurred from bilateral lower lobar pneumonia of hypostatic or rather pneumostatic nature some six months after the patient—a woman aged 22 years—first reported sick with remittent attacks of dyspnœa.

Sections of the tumour show it to be a basal cell carcinoma with pseudocystic changes. It does not originate from the thyroid gland, and probably arose from either (a) ectopic thyroid tissue (b) an ectopic salivary gland rest (*vide* Ewing, *Neoplastic Diseases*, 4th ed. pages 788-9).

*Specimens*—Larynx and trachea. Section of tumour. Shown by courtesy of Dr L H D Thornton, Salisbury.

Lt Col NORTON CANFIELD asked whether the tumour was visible by tracheoscopy. Could it be seen below the vocal cord?

C A HUTCHINSON said that he had never seen the patient himself, but understood that the tumour had been seen in the lumen of the trachea by another laryngologist on endoscopy, and that he had reported on it as presenting the appearance of a largish area of congestion in the subglottic area.

The question was how such a tumour could be diagnosed in the early stages, and when it was diagnosed what could be done for the case.



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## WOUNDS IN THE EAR AND MASTOID REGION

By R WHITTAKER MAJOR, R A M C

THE object of this paper is to present a series of mastoid wounds and to discuss their treatment in the light of modern developments in wound treatment in general

Since February, 1944 I have kept notes of soldiers with wounds in the ear and mastoid regions who have been admitted to the Hospital to which I am attached. Mastoid wounds bore a bad reputation in the last war. I have no means of estimating what proportion of the cases have reached the base. There is a Maxillo-Facial Unit (M F S U) and a Mobile Neuro Surgical Team (M N S U), working with the hospital and the head cases from the most active parts of the Italian front have been sent here. Evacuation from the front has been well organized and cases have usually arrived within two days of having been wounded. It has been a very busy period and cases have had to be further evacuated to North Africa or to the United Kingdom as soon as they were fit and a ship was available, consequently I have not been able to follow them up. I regret any incompleteness in the notes, which were kept as fully as possible under the circumstances.

This series consists of thirty cases. It does not include some serious penetrating head injuries, which were under the care of the Neuro-Surgeons, and which, incidentally, involved the mastoid region. Many patients had other serious wounds which complicated the treatment of the head injury. Classification is difficult. I shall present short summaries of the individual cases, grouped into (1) those with no bone injury to the mastoid demonstrated, (2) those without infection, and (3) those which became infected. I shall follow this by more general observations.

## Cases with no Bony Injury to the Mastoid demonstrated

CASE I. P.O.W. B. was wounded on February 6th, 1944. I first saw the patient about eight days after this. He had a ragged infected wound of the left temple and a perforation of the left ear-drum with middle-ear infection. He was concussed at the time of wounding and when he first recovered consciousness was very giddy. X-ray showed no bony injury. There was complete nerve deafness and facial paralysis on the side of the wound and he had nystagmus to both sides. Treatment was conservative; Sulphathiazole 20 gm. by mouth, aural toilet and hypertonic flavine dressings to the wound. He was transferred to a P.O.W. hospital on March 8th, 1944. His wound was healed, the middle ear almost dry, and he had slight nystagmus to the right. There was no recovery of the deafness or the facial paralysis.

*Comment.* There was presumably an injury to the petrous bone not shown on X-ray. He had no leakage of cerebrospinal fluid.

CASE II. P.O.W. F. was wounded on March 19th, 1944 by a shell fragment which passed through the tragus in front of his left ear. X-ray showed no bony injury and a large flat piece of metal lying at the base of the skull lateral to the atlas. At first there was profuse hæmorrhage from the wound. I first saw him nine days after the injury. The wound was healed. He had dysphagia, hoarseness and trismus. There was complete paralysis of the left nerve, the palate, vocal cord and pharynx on the left side, with a partial deafness. The trigeminal nerve was not injured. The external auditory meatus was full of granulations and epithelial debris, after removing which his ear-drum was found to be intact. Treatment was confined to aural toilet and the damaged meatus cleared up fairly readily. There was no recovery of the nerve paralyses but he learned to swallow and speak quite well. He was transferred to a P.O.W. hospital on April 10th, 1944.

*Comment.* I discussed the question of the removal of the foreign body with my colleagues, but decided against it.

CASE III. Gnr. H. was wounded March 29th, 1944 by a shell fragment which passed through the anterior part of the lobe of the left ear. X-ray showed the missile lying near the lateral mass of the atlas on the left side. No bony injury was seen. He had complete nerve deafness and facial paralysis on the side of the wound. At first the auditory canal was full of wax clot and concretions of sulphonamide powder. Some days later after the wax had been removed, the tympanum was found to be intact. He was examined on April 10th, 1944.

*Comment.* The wound was practically healed when I first saw him ten days after the injury.

CASE IV. Pte. D. had a through and through bullet wound of the zygomatic region to immediately behind the lobe of the left ear. X-ray showed no bony injury to the mastoid process or mandible. At first his face was swollen and there was anæsthesia of his left cheek. He complained of tinnitus. After removing wax from his left ear, the tympanic membrane was seen to be normal and there was no deafness to the usual clinical tests. There was a paresis of the lower part of his face. He had two attacks of convulsions from the wound behind his ear, Major Clarkson, 4 M.F.S.U. explored

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on April 28th, 1944, and ligatured the posterior facial vein, which had been responsible for the bleeding. The wound healed rapidly, and the facial paresis and anaesthesia of his cheek recovered.

**CASE V.** Pte. J. had a through and through bullet wound on April 20th, 1944, from  $1\frac{1}{2}$  inches lateral to the angle of his mouth on the right side and at the same level, to the skin over his right mastoid process. The track appeared to be superficial. X-ray showed no bony injury. Soon after being hit he felt he was falling to the right. Slight nystagmus to the right side was present. He had an incomplete nerve deafness on the right. There was no facial paralysis. The external auditory meatus was extremely swollen, bruised and desquamated. I could not see the drum head. 5 days after admission he was transferred to a Canadian Military hospital, on April 26th, 1944.

*Comment.* At this time I had not a Bárány noise box and I was not sure that his deafness was not complete.

**CASE VI.** Fus. B. had a through and through wound by a shrapnel fragment on May 7th, 1944, from 1 inch to the lateral side of the left eye to the lower part of the left mastoid process. The track was superficial and there was no bony damage. Debridement and primary suture were performed the following day at a C.C.S. under local anaesthesia. "Parotid gland injured, superficial temporal artery exposed." I first saw him on May 18th, 1944, when he had healed lacerations of the tragus, auricle and the floor of the meatal orifice. The external auditory meatus was swollen and the tympanic membrane obscured by debris. He had an incomplete nerve deafness and a facial paresis mainly of the upper branches. After treatment of the damaged meatus had reduced the swelling, the ear-drum was seen to be intact.

**CASE VII.** Pte. B. amongst other serious wounds had a through and through bullet wound on May 17th, 1944, from 1 inch in front of his left ear to below angle of his left mandible. X-ray showed a fracture of the neck of his mandible but no bony injury to his mastoid process. I saw him a fortnight later when his external auditory meatus was completely blocked by swelling of the skin and a large serous bulla. He had a complete facial paralysis on the left. After treatment his meatus improved very much and his drum was found to be intact. He could hear conversational voice at 18 feet on the affected side. Two weeks later he was transferred to a Canadian hospital. He could then move the corner of his mouth and his platysma muscle on the left but his meatitis had to some extent recurred.

*Comment.* This patient had in a severe form the damage to the external auditory meatus which occurs so commonly in these cases. The facial nerve was damaged in its course through the parotid gland.

**CASE VIII.** Lt. N. on July 6th, 1944 had a through and through bullet wound from below the left naris to the left sub-occipital region. X-ray showed no bony injury. His external auditory meatus was full of granulations and blood-clot. After removing these the ear-drum was found to be intact. The roof of the deeper meatus was lacerated, and was the source of the bleeding. There was a middle-ear deafness (conversational voice at 4 feet). He had a paresis of the left facial nerve which became complete in three days and later recovered without interference. The meatal wound healed readily.

*Comment.* I have seen other cases of through and through bullet wounds

immediately below the base of the skull, with cranial nerve paralysis. All those I have seen have healed readily and well.

CASE IX. Sgt. H. had a shell wound of the inferior part of the external auditory meatus on the right (August 11th, 1944). A small piece of metal was removed from this at a C.C.S. During the next five days, whilst in transit and in hospital, he had six attacks of hæmorrhage from the wound, which were controlled by firm bandaging. By this time he had developed an aneurysm in front of the ear. There was also an infected middle ear and a complete facial paralysis. X-ray showed no bony injury. Operation August 18th, 1944—Ligature of the external carotid artery. The pulsatile swelling disappeared immediately. For about six days there was considerable bloody purulent discharge from the puncture wound in the meatus, after which this and his infected middle ear rapidly resolved. He had a partial middle-ear deafness.

## Cases with Bony Injury but no infection of the Mastoid

CASE X. Sgt. R. sustained a through and through wound by a shell fragment on February 7th, 1944, from  $1\frac{1}{2}$  inches in front of the left ear to the left sub-occipital region. The deeper part of the external auditory meatus was lacerated and there was perforation of the membrane and infection of the tympanum. X-ray showed the mastoid tip fractured. He had a complete nerve deafness and facial paralysis on the left. When I first saw him four days after wounding, the entrance and exit wounds were clean and already healing. He was treated conservatively and returned to his unit on February 25th, 1944. The ear-drum and meatus were healed. The facial paralysis had recovered. The deafness remained complete.

CASE XI. Pte. R. in February 20th, 1944, a shell fragment hit the lower part of his left mastoid and passed to the inner side of the neck of the mandible. X-ray showed a fracture of the tip of the mastoid process. The tympanic membrane was intact, there was partial deafness of the middle-ear type (conversational voice at 10 feet), and a facial paresis. His wound healed by first intention without interference, and his facial paresis recovered completely. His hearing improved but the extent of the improvement was not noted. He returned to his unit March 6th, 1944.

*Comment.* I first saw this patient a week after he was wounded. The wound was healing and no attempt was made to remove the foreign body. He had some trismus which recovered spontaneously.

CASE XII. Sgt. H. was wounded on March 18th, 1944, by a hand-grenade, in front of and below the right ear. X-ray showed fracture of the neck of the mandible. The tympanic membrane was intact, but there were granulations on the floor of the external auditory meatus. When he was first injured he was very giddy and found himself falling to the left. He had complete nerve deafness and facial paralysis. Treatment as far as his ear was concerned consisted of aural toilet of the meatus which cleared up well. On April 10th, 1944 he still showed a tendency to fall to the left and had slight nystagmus to the right. He was evacuated on April 28th, 1944, he could move the lower part of his face on the injured side and his vertigo had disappeared.

CASE XIII. Fr. Soldier M. was wounded on March 19th, 1944, by an S mine ball which entered 2 inches in front of the right ear. X-ray showed

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shattering of the mastoid process, fracture of the ascending ramus of the mandible, and a metallic foreign body lying below the tip of the mastoid. The external auditory meatus was desquamating and swollen, with hæmorrhage into the skin, and there was a perforation of the ear drum with pulsating purulent discharge. He had a complete right nerve deafness and facial paralysis. On April 17th, 1944 I explored the mastoid process and removed the foreign body. There was no obvious mastoid infection. I removed the mastoid tip and exposed the facial nerve at its exit from the stylo mastoid foramen. I did not attempt to explore the nerve further and I did not open the mastoid antrum. His middle ear infection resolved slowly but completely and he was transferred to a French Military hospital.

*Comment* The operation was unnecessary as the mastoid was not infected and exploration of the facial nerve was not practicable.

CASE XIV Pte H was wounded by a shell fragment, which entering through the right mastoid region, penetrated into the posterior fossa of the skull. He was very drowsy and had inco-ordination and atonia on the right side. There was a history of discharge from the right ear in childhood, followed by deafness. This recurred when he was wounded and his deafness increased. Operation (48 hours after wounding) with Capt Jepson, 5 MNSU. The wound was excised and the dura widely exposed, the posterior mastoid cells being removed. The lateral sinus had been torn across and was thrombosed but the dura was otherwise intact. The foreign body was removed and the wound sutured in two layers after insufflation of penicillin powder. The wound healed by first intention. There was a large perforation of the drum head with a moderate amount of muco purulent discharge. This dried up with local treatment. His hearing then was conversation voice at 1 foot, with no loss of absolute bone conduction. He returned to duty in Category B 1.

*Comment* With early wound excision no infection supervened.

CASE XV Cpl M sustained a large shrapnel wound behind his right ear on April 6th, 1944. The wound was explored at a CCS, and two large foreign bodies removed. X-ray showed a fracture of the mastoid process. He had a complete nerve deafness and facial paralysis on the right. I saw him four days after he was wounded. There was no meatal discharge. I could not see his tympanic membrane, owing to the presence of blood clot and wax. He had a course of sulphonamide, his wound was clean and he was evacuated a day or two later.

CASE XVI L/Cpl B had a shell-fragment wound of the right mastoid area on May 2nd, 1944. The missile was present in the roof of the right maxillary antrum. He was admitted 9 days after wounding, his wound had been debrided and sutured in an American hospital and had healed. His tympanic membrane was intact, hearing, "conversational voice at 3 feet, type not noted", he had a complete facial paralysis, and anæsthesia of the area supplied by the second and third divisions of the trigeminal nerve. These paralyses cleared up spontaneously before he was evacuated.

CASE XVII Lt T had a shrapnel wound on May 12th, 1944 of the left auricle and mastoid. The external ear was divided into upper and lower halves and there was a 3 inch lacerated wound over the mastoid process. After he was wounded the patient himself removed the missile. The following



day the wound was explored digitally at a C.C.S. "The mastoid tip was found to be detached", and a sulphonamide and vaseline gauze dressing was applied. On May 17th, 1944 I did a delayed suture of the auricle and of the mastoid wounds, which were clean, draining the posterior wound for two days. The latter partially broke down but both were healed when he was evacuated on May 29th, 1944. The tympanic membrane was intact. He had a deafness of the middle-ear type (conversational voice at 12 feet), which improved.

*Comment.* The wound healed after delayed suture without interference with the damaged bone.

CASE XVIII. Bdr. L. was wounded by a shell fragment  $1\frac{1}{2}$  inches below and behind his right mastoid tip. X-ray showed a piece of metal in the right petrous bone, about the jugular foramen. There was leakage of blood and cerebrospinal fluid from the ear, and complete paralysis of the right VIIIth, IXth and Xth cranial nerves. His facial nerve was not affected. On August 8th, 1944 operation (with Capt. G. K. Tutton, 5 M.N.S.U.). The incision excised the entry wound and continued upwards parallel to the post-auricular groove. The mastoid process was removed, the sinus was extensively exposed and followed down to the junction with the jugular bulb. Here was lying a large foreign body which had torn the jugular vein at its exit from the skull. When the clot over this was disturbed there was alarming hæmorrhage. This was controlled by a large muscle graft and the metal removed gently in a clear field. The dura was intact. The wound was sutured after insufflation of penicillin. After operation he had a facial paralysis, which came on in about 6 hours. The wound healed by first intention; a fortnight later, three small sequestra came away from the floor of the external auditory meatus, which then rapidly healed, his ear drum being already dry and healed. His speech and swallowing also improved, but the paralyses were still complete. Slight nystagmus persisted, but his vertigo disappeared. He was evacuated on September 2nd, 1944. There was no recovery of his facial paralysis.

*Comment.* Operation would have been difficult in this case without the experience and facilities of the neuro-surgical unit.

CASE XIX. L/Sgt. B. suffered a through and through wound on August 17th, 1944 from the right external angular process to the right mastoid area. He was stunned for a few minutes and then was deaf and very dizzy. There was no leakage of cerebrospinal fluid. Operation was performed the same day (Capt. Tutton), at the forward section of the neuro-surgical unit. "Mastoid wound excised and loose bone removed. Insufflation of penicillin powder and two layer closure." Penicillin powder was applied to the face wound. He had partial nerve deafness, no facial paresis, and no nystagmus. There was a perforation of the ear drum which healed without infection, and the incision healed by first intention. He returned to his unit on August 27th, 1944 at his own request.

*Comment.* Early wound excision and primary suture prevented infection.

## Cases with Infection of the Mastoid

CASE XX. Tpr. R. was wounded on February 5th, 1944, by a large shell fragment, 2 inches in front of the left ear, which passed backwards and inwards. The external auditory meatus was severed except for part of the roof. A large

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metallic fragment was lying across the torn meatus and other smaller ones were ground into the comminuted mastoid process. X-ray showed fracture of the neck of the mandible, shattering of the mastoid, and foreign bodies as described above. There was complete nerve deafness and facial paralysis. I saw this patient 5 days after wounding and removed the large foreign body through the wound of entry. Infection was established, and there was profuse purulent discharge from the wound and from an infected middle ear. On February 19th, 1944 I explored the mastoid through the usual post-auricular incision and removed foreign bodies and loose bone, including the posterior bony meatal wall, and then completed the radical mastoid operation as far as possible. The deeper mastoid cells appeared to be uninfected. I left the wound open. Profuse foul discharge continued for about 10 days after which the entry wound healed and the external auditory meatus and the mastoid wound became slowly cleaner. The patient was evacuated on March 2nd, 1944.

*Comment* Had I seen this case after more experience I should not have done more than remove the loose bone. He had a high temperature after operation and was seriously ill. Later he will require plastic repair to drain the mastoid cavity into the meatus and possibly exploration of the facial nerve.

**CASE XXI** Pte K had several machine gun bullet wounds on February 15th, 1944 amongst which was a through and through wound from the left mastoid area to the left sub occipital region. The auricle was lacerated in its lower part. There were perforation and infection of the tympanum. X-ray showed comminution of the mastoid process. He had an incomplete deafness of the middle ear type, which improved whilst he was under observation, and complete facial paralysis. There was no history of vertigo and no nystagmus present. I saw this patient after wounding when infection of the middle ear, auricle, and mastoid wound were severe and well established. He was treated with sulphathiazole 25 gms in 4 days and minimal local treatment. He was evacuated on March 25th, 1944 with a dry perforation of the ear drum, and the mastoid and auricular wounds healing well by granulation. There was no recovery of the facial paralysis.

*Comment* Had this patient's general condition permitted I should probably have explored the mastoid but the infection cleared up well without operation.

**CASE XXII** P O W L on February 18th, 1944 had a through and through bullet wound from the left ala nasi to the left sub occipital region. He was treated with sulphonamide and vaseline gauze dressings. I first saw him 17 days after his injury when both entrance and exit wounds were healed. X-ray showed a fracture of the neck of the mandible and comminution of the mastoid process. He had complete left nerve deafness and facial paralysis. No vertigo or nystagmus were present. There was a profuse purulent discharge from the external auditory meatus, the deeper part of which was a mass of granulations from direct injury by the missile. I treated this conservatively for nine days during which time it rapidly became much cleaner. I then explored the mastoid through the usual post auricular incision. After removing loose bone I smoothed off the resulting cavity, which resembled that of a radical mastoidectomy, and after filling it with sulphonamide powder, sutured the incision without performing a meatal plastic operation. There was no

infection of the mastoid bone. I had to remove a stitch from the mastoid incision to drain it for 4 or 5 days, after which the wound and the external auditory meatus became dry and healed rapidly. The facial paralysis did not recover.

*Comment.* I do not think this operation was necessary. Further conservative treatment would have given the same result. Exploration of the facial nerve was unlikely to be useful at this stage and the unstable condition of the fractured mastoid made it impracticable. I think the mastoid cavity was infected by the operation which opened up the middle ear.

CASE XXIII. L/Cpl. S. sustained a through and through bullet wound on February 18th, 1944, from below the right eye to the right mastoid process. He was admitted on February 29th, 1944, when both wounds had healed. He had a perforation of the right ear-drum and infection of the middle ear. X-ray showed fractures of the roof of the right maxillary antrum, the ascending ramus of the mandible and the tip of the mastoid process. The mastoid cells were blurred. Deafness appeared complete and there was a right facial paresis. By March 3rd, 1944, he had developed the signs and symptoms of acute mastoiditis, fever, pain, tenderness, and profuse discharge. I performed a cortical mastoidectomy and found the cells full of muco-pus. On evacuation, March 20th, 1944, he had a dry perforation of the ear-drum with recovery of hearing to conversational voice at 12 feet, complete recovery of the facial paresis and the mastoid incision also healed.

*Comment.* The healing of the mastoid wound, the late development of the mastoid infection and its clinical course, with the findings at operation suggest that the infection spread from the middle ear to the mastoid. This is the only such case in this series.

CASE XXV. Pte. S. had a shell fragment wound on February 28th, 1944. The missile entered at the tip of the left mastoid process. X-ray showed a fracture of the tip of the mastoid process and the styloid process with destruction of the neck of the mandible. There was a perforation of the ear-drum with profuse purulent discharge. He had a complete left nerve deafness and facial paralysis. On March 10th, 1944, operation—Capt. Lawrie, 4 M.F.S.U., "Removal of foreign body through entrance wound; followed by profuse torrential hæmorrhage, probably from the internal maxillary artery. Controlled by packing. Further dressings were done in the operating theatre." There were no further hæmorrhages whilst this patient was under my observation. His wound was deep, infected and narrow, but very much cleaner when he was evacuated on March 25th, 1944.

*Comment.* I first saw this man about a week after his operation and treated him conservatively. Fortunately the expected secondary hæmorrhage did not occur. The middle-ear infection was much improved.

CASE XXVI. L/Cpl. A. was wounded May 14th, 1944, by a shell fragment which entered his right cheek, passing to the right mastoid process. The temporo-mandibular joint was destroyed, the auditory meatus lacerated, and the mastoid process comminuted. X-ray also showed a fracture of the anterior fossa of the skull. He had a partial sensory paralysis of the right trigeminal nerve and a complete facial paralysis. Some hearing remained. On May 16th, 1944, large foreign bodies were removed and the face wound was sutured at the

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forward section of No 4 Maxillo-Facial Unit I saw the patient on June 1st, 1944, when he had a profuse purulent discharge from the auditory meatus, which was completely blocked by granulations at the orifice. I curetted these away the following day and found a suppurating cavity draining into the anterior part of the meatus. The posterior bony meatal wall was exposed, comminuted and with small pieces of metal impacted into it. Profuse purulent discharge continued. On June 7th, 1944, I performed a radical mastoidectomy. After removing loose bone the deep mastoid cells were found to be full of blood but not infected. The facial nerve was seen issuing from the stylo-mastoid foramen intact. Exposure of the nerve in its vertical course was not attempted as the bone was loose and unstable. After a modified meatal plastic operation penicillin powder and a dry gauze pack were inserted and the posterior wound sutured. The patient had nystagmus for two days after the operation, his general condition being good. On evacuation on July 5th, 1944 the posterior wound was healed, the mastoid cavity discharging freely but granulating well, with some small bony sequestra to come away. The facial paralysis had not recovered at all. He had some hearing.

*Comment* Operation would probably have been better confined to removal of loose bone, in which case I think infection would have been less slow in resolving.

CASE XXVII Fus B had a mortar fragment wound of the left ear and mastoid region on May 17th, 1944. He did not lose consciousness but was very giddy immediately after wounding. A fragment of metal was removed and the wound dressed with sulphonamide and vaseline gauze at a C C S. When seen 36 hours after wounding there was a horizontal laceration of the whole auricle, dividing it into two halves, from the meatal orifice to the posterior margin, and a 2 inch long horizontal wound over the mastoid process. X-ray showed a large metallic foreign body in the left posterior fossa of the skull. He had complete VIth and VIIth nerve paralysis and complete nerve deafness on the left, gross nystagmus, tremor and inco-ordination of fine movements. Operation was performed soon after admission (with Major Shoreston, 5 M N S U). The wound was excised and an incision made 2 inches behind and parallel to the post auricular groove, and the auricle reflected forwards. The loose bone of the shattered mastoid process was removed and the sinus extensively exposed. This had been lacerated by the fragment and bled profusely. After this had been controlled by a large muscle graft the bone was removed over the posterior fossa behind the sinus and the metallic fragment removed. The dura of the posterior fossa was intact and there was no cerebrospinal fluid leak. There now remained a large cavity, practically that of a radical mastoidectomy, with the ossicles and some remains of the tympanic membrane still present. This was insufflated with penicillin powder, packed with dry gauze and drained through an enlarged external auditory meatus. The original wound and the incision were sutured. The auricle healed well, but after 5 days the posterior wound broke down partially. He was evacuated about fourteen days later, the cavity clean except for one or two small sequestra on its floor, and the wound healing by granulation. There was no recovery of the nerve paralysis.

*Comment* This was a case when primary closure could not be carried out

owing to the destruction of the skin of the meatus, but the treatment adopted was "next best" and his general condition gave rise to little anxiety. He was walking about before evacuation, with no subjective vertigo, but still some nystagmus.

CASE XXVIII. Fus. S. on June 18th, 1944, had a long ragged wound on his left mastoid area to a point over the left supra-spinatus muscle. X-ray showed detachment of the tip of his mastoid process and a fracture of the posterior fossa of the skull. I saw him 14 days after his wound, when the external auditory meatus was completely blocked by granulations and discharge. His wound was infected. There was no facial paralysis and no nystagmus or history of vertigo. Four days later, after treatment with sulphathiazole by mouth and hypertonic flavine dressings to his wound, it was sufficiently clean to perform secondary suture. This I did without removing his mastoid tip. The wound healed except for its lower part which broke down and healed slowly by granulation. The meatal swelling was reduced after treatment and the drum could be seen with an infected perforation. This also healed in a fortnight leaving the ear-drum scarred and immobile, with hearing reduced to conversational voice at 1 foot.

*Comment.* The breakdown of the lower part of his wound was probably due to the difficulty in immobilization of the neck. His progress shows that an infected middle ear and a mastoid wound can be successfully treated without mastoidectomy, almost independently of each other, that is that the mastoid wound can be treated on its merits, middle-ear infection not being considered. The latter usually responds to conservative treatment.

CASE XXIX. Sgt. H. had a through and through wound from under the left orbit to the middle of the left mastoid process on June 21st, 1944. He had a profuse leak of cerebrospinal fluid from the left ear and complete nerve deafness and facial paralysis on the left. X-ray showed a fracture of the left petrous bone into the inner ear and detachment of the outer part of the mastoid process. He was treated at the forward section of the Neuro-Surg. Unit. For the first week he was drowsy with neck rigidity and fever. He was treated conservatively with a full course of sulphadiazine and the ear became dry. On July 10th, 1944, there was profuse purulent discharge from the left ear though his general condition remained good. He was admitted to the base hospital July 12th, 1944. His infra-orbital wound was healed. The external auditory meatus was blocked by a flap of torn posterior meatal wall, pressure on which caused a discharge of pus from meatus and the mastoid wound. On July 19th, 1944, he was operated on (Lt. Col. W. A. Mill) with the usual mastoid incision. The outer table and tip of the mastoid process were loose. After removing these a large granulation-filled cavity was uncovered and in its medial wall the exposed lateral sinus could be felt. The antrum was not searched for and mallet not used because of the serious fracture of the petrous. The mastoid wound was packed with vaseline gauze; a rubber tube was left in, through which sodium penicillin was injected daily for five days without disturbing the dressing. At the first dressing the wound was clean and showed signs of healing by granulation so rapidly that secondary suture was not considered necessary. The torn external auditory meatus also healed, disclosing an infected perforation of the ear-drum, which dried up readily.

## Wounds in the Ear and Mastoid Region

*Comment* X ray showed a wide open channel for infection to reach the meninges. Conservative treatment was successful for his meningitis.

CASE XXX Pte P This patient was not a battle casualty. On July 10th, 1944 he fell over a cliff and sustained a closed head injury, being stunned for an hour. X-ray showed a linear fracture of the right temple. There was a hæmotympanum with intact drum on the same side. A week later this became infected without making the patient ill, and scanty aural discharge was present with a perforation of the ear drum. On August 3rd, 1944, he had fever and an abscess of the scalp, which appeared to be subcutaneous, over the fracture. This was incised but the wound did not heal. On August 15th, 1944, X-ray showed blurring of the mastoid cells and of the bone at the margin of the fracture. Operation—Lt Col Mill, Capt Tutton, on August 15th, 1944. "A sinus from the opened abscess led to the fracture and about half a square inch of bare bone. An incision was made from above this sinus to the mastoid tip, the bone was removed from over an extra dural abscess, the dura being covered with granulations without much pus. The fracture led down to a crack in the roof of the tympanum. The scanty mastoid cells were full of muco pus. After performing a cortical mastoidectomy, the wound was sutured and two tubes inserted through which penicillin was instilled daily for eight days. After this period the meatus was dry, and the wound healed readily. He left hospital with a healed ear drum and only slightly impaired hearing.

*Comment* The sequence of events was probably infection of the extra dural hæmatoma via the Eustachian tube and the hæmotympanum.

### Discussion

When I first saw cases with wounds of the mastoid, I was impressed by the frequency of associated perforation and infection of the middle ear. I expected this infection to spread to the injured mastoid process and thought that exenteration of the cells was necessary, particularly as there might be a fracture of the petrous bone and a channel for infection to reach the meninges. Later I found that spread of infection from the middle ear to the mastoid cells is rare (Case II in this series) and can be treated by later mastoidectomy if it occurs.

The early cases I saw were for the most part late and infected (XX, XXII, XXVI). In some of these I did a formal mastoidectomy. At operation it usually appeared that infection was confined to the damaged bone and had not involved uninjured mastoid cells. Later on, even in infected cases, I confined interference to removal of loose bone, without drainage of the mastoid cells or of the mastoid antrum. I found that these cases cleared up more quickly after this simple debridement. Conservative treatment for a week or two, to control and localize the infection, with sulphathiazole or sulphadiazine and infrequent local dressings undoubtedly shortens the period of illness, and in some cases (e.g. Case XXIV) operation has been unnecessary. With penicillin more generally available, infection can be prevented and controlled much more easily (Cases XIV, XVI, XVIII, XIX).

## R. Whittaker

In treating early cases, when the opportunity arose, I found that excision and primary suture, with insufflation of penicillin, prevents the development of infection and leads to healing by first intention. Primary closure may be impossible owing to loss of skin or damage to the external auditory meatus. In these cases (e.g. XXVI, XXVII) debridement—removal of damaged skin and loose bone, with delayed suture, or healing by granulation is successful. The performance or not of a meatal plastic operation must depend on the extent of the damage and infection. I think that in general it is best left for a second operation; sometimes it heals in a surprising and gratifying manner without interference (e.g. Case XXIX).

*Forward treatment* should be confined to control of hæmorrhage and penicillin or sulphonamide and vaseline gauze dressing. The cases should be evacuated early, preferably to an otologist working at a "head centre". This should certainly be done if there is X-ray or neurological evidence of a penetrating head injury and dural damage, when the case is primarily one for the neuro-surgeon, with whom the otologist should co-operate.

X-ray of a fractured mastoid usually shows opacity and blurring of the cells as well as the bony injury. This is due to hæmorrhage, but may suggest infection.

### Complications

*Infection of the middle ear* is almost inevitable if there is a perforation, and a perforation is usually present, due either to blast injury, or to the local explosive effect of the missile in the tissues. I think this infection occurs (1) because the patient is bandaged for some days (similarly a bandaged eye will develop conjunctivitis), (2) because blood and dirt get into the meatus at the time of wounding, (3) sometimes drops or powder are inserted to prevent infection.

This last practice has been discontinued in the Army and Medical Officers are advised to do nothing apart from inserting a piece of sterile cotton wool loosely in the meatus. As I have stressed above, middle-ear infection rarely spreads to the mastoid. In this series it has responded well to regular conservative treatment, daily careful mopping out of pus and debris, and insufflation of boric acid powder.

The wounded *auricle*, heals well, with primary or secondary suture. I have made it a practice to excise about 2 or 3 mm. of the edge of torn cartilage, but only obviously damaged skin, and to suture the skin with fine waxed silk.

*The external auditory meatus* apart from direct lacerations, has almost constantly shown swelling, hæmorrhages and desquamation, with the later appearance of persistent granulations. I think this is due to sudden distortion and cracking by the explosive effect in the tissues

# Wounds in the Ear and Mastoid Region

of the missile passing close by, with cracking sometimes down to the cartilage. In treatment, regular, complete mopping out of debris and desquamated skin is the essential, and the insertion of a wick or ribbon gauze in a suitable mild astringent or antiseptic of which I have found silver nitrate ( $\frac{1}{4}$ -1 per cent.) the best. Granulations must sometimes be curetted, but they usually disappear eventually after regular application of a suitable caustic such as chromic acid, 50 per cent.

*Facial paralysis* is not an indication for operation. There seems to be a fair chance of spontaneous recovery, even when associated with complete nerve deafness (Case X) or in the presence of sepsis and severe bone damage. Exploration with a view to repair, should be postponed as it is often impracticable, because the bone is loose and unstable. (Cases XIII, XXII, XXVI).

## Prognosis

*Hearing.* Complete nerve deafness is of course permanent. Middle-ear deafness associated with perforation and otitis media usually improves as the infection abates.

*Facial Paralysis.* This is difficult to judge as mentioned above.

*Labyrinth.* With the destruction of one labyrinth, vertigo is usually extreme at first, but as in destruction of the labyrinth by infection, subjective vertigo slowly disappears although nystagmus may persist for a good while.

*Other Cranial Nerve Paralysis.* Cases II and XVIII showed paralysis of tongue, palate, larynx and pharynx on one side which showed no recovery whilst under observation. Both patients however learned to speak and swallow fairly well in two or three weeks. I have seen two other similar cases not included here, who compensated for their disability in the same way.

## Later Treatment

Some of the cases I evacuated will require later-plastic operation on the auditory meatus to drain the mastoid cavity, and to close a posterior wound. Some also will require exploration of the facial nerve.

I hope some account will be published of the final results in this type of case.

I wish to thank Lieut.-Colonel W. A. Mill, R.A.M.C. for his help and criticism in preparing this paper, and the Officers Commanding and Staffs, of No. 5 Mobile Neuro-Surgical Unit, and No. 4 Maxillo-Facial Unit for their co-operation.

I have also to thank the Commanding Officer of the General Hospital for permission to publish these notes.



# ANTRAL RHINOLITHS

By OLIVER C. LORD (Leeds)

THE presence of a rhinolith in the nasal cavities is not uncommon, and one or two cases occur each year in a large E.N.T. clinic. There is no recorded instance of a rhinolith forming in the frontal sinus, and its occurrence in the antrum is very rare, only six cases have been recorded in the literature and only one case in English publications. It seems, therefore, appropriate to review the literature and record a further case which I have had the opportunity of treating.

## Review of the Literature

The first two cases are recorded in ancient medical works of the years 1686 and 1738 respectively. The earlier one was described anonymously and the later one by Lanzoni, although Oppikofer comparing the two Latin texts concluded that the two accounts referred to one and the same case, Lanzoni's description being a copy of the first. The patient suffered for many years with a vesical calculus which was removed by operation. He was then troubled by great pain in his right upper jaw followed by an external swelling, which was incised and a hard irregular stone, the size of a pea was removed.

Zuckerkindl described a case after death in which there was expansion of the antrum with bulging into the nose and broadening of the alveolar margin. A stone about the size of a hazel nut, whose structure corresponded exactly with that of a rhinolith, was removed from the antrum, but owing to decomposition the condition of the antral mucosa could not be determined.

Harke's case also observed post mortem described a stone, the size of a pea found in an antrum full of foul pus.

The case described by Kahnity presented as a profuse epistaxis. The right antrum contained offensive purulent material and a chalk stone, the size of a hazel nut, which had eroded a branch of the internal maxillary artery. There is no description of a nucleus occurring in these cases.

Oppikofer's case was a woman, aged 60 years, who had complained for 20 years of muco-purulent discharge from the right nostril usually moderate in amount, but occasionally profuse and fœtid and accompanied by pain in the right side of the face. Exploration of the right antrum showed a considerable amount of fœtid pus. The Caldwell-Luc operation was carried out, and a stone was found in the floor of the antrum, in size rather larger than a hazel nut. Its chemical composition resembled

## Antral Rhinoliths

a rhinolith but there was no exogenous nucleus. Oppikofer then states that histological examination of the antral mucosa showed extensive carcinomatous change and since this had been removed completely there was no recurrence. It seems probable that chronic inflammatory changes in the antral mucosa gave a fallacious impression of malignancy.

A. J. Wright reports a case of a rhinolith occurring in the antrum in a male, aged 24 years, who had eight years history of nasal discharge due to right-sided fronto ethmoidal and antral suppuration. Drainage of the frontal and ethmoidal sinuses and the antrum was carried out intranasally. This failed to clear the condition and Howarth's operation on the frontal sinus was performed. Six weeks later the patient blew out from the right side of the nose, a foreign body which proved to be a rhinolith. The nucleus was the root of a molar tooth which had been removed years before, the root apparently being displaced into the antrum at the time and suppuration ensued with subsequent incrustation around the tooth nucleus.

### Case Report

G. A., a male of 50 years attended the out-patient department of the General Infirmary at Leeds in July 1942 complaining of left-sided nasal obstruction and purulent discharge of some twelve months duration. Only slight discomfort was experienced at first but for the preceding two months the nose had been very troublesome. There was no history of frequent colds or previous nasal trouble, or the introduction of a foreign body into the nose. His teeth had been extracted two years previously and this had caused no nasal trouble or undue discomfort. Examination of the nose showed the left side to be full of typical polypi arising in the middle meatus and associated with purulent discharge. Transillumination of the sinuses demonstrated dullness of the left antrum. The right nostril and sinuses were clear. The polypi were visible on examination of the post nasal space. Antral lavage showed much pus and a diagnosis of chronic unilateral antral and ethmoidal suppuration with polypi was made. No radiograph of the sinuses was taken.

In August 1942 under general anaesthesia a left Caldwell-Luc operation was performed. This showed the antrum to be full of non-fœtid pus, which after aspiration revealed a calculus lying free in the antrum. The calculus was removed. The antral mucosa, being thickened œdematous and polypoidal, was removed. There was no suggestion of malignancy. The usual intranasal opening was made into the inferior meatus and intranasal ethmoidectomy with removal of the polypi and drainage of the ethmoid cells was carried out. There was no evidence of frontal sinus infection.

His progress was very satisfactory. He was seen two weeks after

## Oliver C. Lord

operation when the nose was healing well. He had no further complaints and was seen by request in August, 1944. He felt very well and his nose caused no trouble whatsoever. Examination showed no recurrence of polypi, the opening into the antrum was patent and there was no evidence of infection. Transillumination of the sinuses was quite clear.

### Description of the Antral Rhinolith

This was an oval shaped stone measuring 18 by 13 by 6 mm. It resembled a plum stone in shape and size and possessed a craggy, irregular surface. (See Figs. 1 and 2.) It was stony hard in consistency and of a dark brownish-grey colour. The weight was 720 mgm. The outer calcareous shell of one surface, varying in thickness between 1 and 2 mm. was removed. This revealed a little dry debris, but beneath this forming the core and measuring 10 by 7 by 3 mm. was a collection of paper, now in several small pieces but probably at one time composed of one rolled-up portion. Printing was clearly visible on at least two pieces, the letters "e" and "l" being quite distinct. (See Fig. 3.) The paper had obviously formed a nucleus around which incrustation had occurred. The small part of the rhinolith removed was kindly examined by Dr. Fowweather who reported: "This rhinolith consists mainly of Calcium phosphate together with a small amount of carbonate and some organic matter." Having with certainty discovered a nucleus the specimen was preserved.

### Discussion

It is interesting to consider the probable sequence of events in the formation of this rhinolith in the antrum. It seems certain that a piece of paper was introduced into the nose at some time, this is most likely to have taken place in childhood. This foreign body has then passed from the nose into the antrum through the normal ostium, an extremely unusual sequence, and the presence of a piece of paper instigated supuration in the antrum. Presumably as in the formation of an ordinary rhinolith the pus became concentrated by the air current in the nose and antrum, and by inadequate drainage. In consequence the pus was concentrated beyond the point at which salts, especially calcium will remain in solution. These were then precipitated on the surface of the paper causing incrustation and the subsequent formation of the rhinolith.

Such would appear to be the method of formation of the rhinolith in this case. Several interesting features however are revealed. We know it is not uncommon for children to introduce pieces of paper into the nose. Furthermore a nucleus of paper is not infrequent in a rhinolith. Polson reviewing the literature found a paper nucleus in 13 out of 209

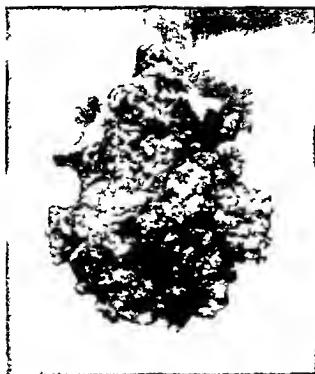


FIG 1



FIG 2

Photographs of antral rhinolith after removal (magnification  $\times 3$ )



FIG 3

Antral rhinolith after removal of part of outer shell to show the paper nucleus  
Note the printed letters on the paper



## Antral Rhinoliths

rhinoliths It is extremely rare for a foreign body of any appreciable size to pass from the nose *via* the maxillary ostium into the antrum Newcomb discussing foreign bodies in the antrum found isolated examples where a small piece of paper, a fragment of wood or a piece of cotton wool had taken this very unusual course, but no other instances are on record

Foreign bodies occasionally gain entrance to the antrum by an abnormal route due to trauma by accident or operation They are usually teeth, but bullets and other missiles are seen from time to time A peg or other object not uncommonly slipped into the antrum following the obsolete operation for drainage of an infected antrum through the alveolus The presence of a foreign body in the antrum, however, does not always produce incrustation or indeed infection, for Irwin Moore recorded a case where a piece of aluminium remained in the antrum for 25 years without either taking place

All the recorded cases of antral rhinolith have been associated with suppuration in the sinus and it seems likely that incrustation is a sequel to infection In this case it appears reasonable to assume that the paper nucleus was present in the antrum for some considerable time, probably many years, and it was later when infection occurred in the antrum or latent infection became active and subsequently involved the ethmoids with the formation of polypi, that symptoms were produced causing the patient to seek advice

The first recorded cases contained no description of a nucleus, but there is no suggestion of a search being made In Oppikofer's case where no nucleus was found after examination, it is nevertheless difficult to exclude an endogenous nucleus, and for incrustation to occur around some inspissated pus or blood clot Wright's case and the present one showed definite evidence of an exogenous nucleus

An antral rhinolith is unlikely to produce symptoms *per se* but these depend on the coincident infection in the sinuses Radiography would appear to be important in the diagnosis, but so far no case has been recognized before operation by this means, as all have been found accidentally at operation or ejected spontaneously following drainage of the antrum The treatment of an antral rhinolith, as for any foreign body in the antrum, is without doubt the Caldwell-Luc operation, for this ensures easy removal and enables appropriate treatment to be given to the infected sinus at the same time A small calculus could be removed whilst carrying out intra-nasal antral drainage but this is by no means as certain as the radical operation

There is insufficient evidence to suggest that an antral rhinolith predisposes to malignant disease, but in view of its rarity a rhinolith is not a factor of importance in the ætiology of the malignant antrum

Summary

An antral rhinolith is described which was discovered at operation for the removal of nasal polypi, and drainage of an infected antrum by the Caldwell-Luc operation. The nucleus was a piece of paper which had passed into the antrum *viâ* the ostium. It is suggested that incrustation occurred following suppuration in the antrum. Six previously recorded cases are reviewed.

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## CLINICAL RECORDS

### AN UNUSUAL CASE OF CEREBELLAR ABSCESS

By H S KANDER (Stafford) and W HALLCHURCH (Wolverhampton)

Cerebellar abscess following lateral sinus thrombosis is a comparatively common condition. When the intracranial pressure remains high or even increases after drainage of the abscess, prolapse of brain substance is not unusual. This is generally considered to be due to encephalitis or meningo encephalitis, retention of pus, or possibly the occurrence of an internal hydrocephalus.

It is, however, extremely rare to have a prolapse of cerebellum containing a large abscess into the mastoid cavity after an operation for lateral sinus thrombosis. Neither Macewen nor Eagleton in their standard works on brain abscess mentions this possibility, nor could a similar case be found in the literature. It, therefore, seems to be worth while to record such a case.

#### Case Report

G C, a boy aged 6, was admitted to Cannock Isolation Hospital for scarlet fever on *July 23rd, 1943*. Two weeks later he complained of pain in his left ear which began to discharge on the following day. One month after the onset of the otitis media, on *September 5th*, the child suddenly became semi-conscious with a high temperature, neck rigidity and vomiting. One of us (W H) was called in, otogenic meningitis was diagnosed and operation on the left mastoid performed at once. The dura of the middle fossa was incised and on exposure of the posterior fossa the lateral sinus was found thrombosed and the sinus wall had sloughed. The clot which extended far backwards was removed until free bleeding was obtained. The child made a good recovery and was discharged from the Isolation Hospital on *November 3rd*, with a dry ear, apparently well.

About 2 weeks later the child became pale, listless and lethargic and began to vomit frequently.

He was admitted to the Staffordshire General Infirmary, Stafford, on *November 23rd, 1943*. When seen by one of us (H S K) the boy was found to be quiet and unresponsive. There was no actual vomiting, though he complained of nausea, but he had no headache. He constantly lay on his left side.

The left mastoid wound was completely healed, but the scar was slightly tender. There was a slight brownish discharge from the left ear which subsided after a few days. Hearing could not be tested accurately, but was fair.

Neurologically he showed classical signs of a left cerebellar abscess — Coarse nystagmus to left, hypotonia of left arm and left leg, dysdiadochokinesia of left arm and poor performance of rapidly alternating movements. He tended to fall to the left when standing or walking. His pupils were widely



dilated and there was commencing papilloedema of both discs. Cerebrospinal fluid was under pressure, cells 19 per c.mm. (lymphocytes), protein 70 mgm. per 100 c.c. Otherwise the cerebrospinal fluid showed no abnormality. Blood count showed 15,000 leucocytes with 79 per cent. polymorphs.

The diagnosis of left cerebellar abscess was made and it was decided not to operate immediately, but to await events.

During the following 2 weeks the child settled down quite well, nausea diminished, there was no vomiting and the temperature remained normal. The cerebellar signs, however, remained unchanged. On *December 6th*, it was observed that the child was more drowsy and the papilloedema had become well marked. The white blood count showed 9,400 leucocytes with 48 per cent. polymorphs.

A few days later vomiting started again and on *December 14th*, 1943, the boy developed a complete bilateral external rectus palsy. The mastoid scar was still a little tender, and there was definite fluctuation. About 10 c.c. of thick, creamy pus was aspirated through the scar in the ward. This was followed by operation on the same day.

*Operation* :—The old retro-auricular scar was incised and it was soon clear that the whole mastoidectomy cavity was filled with a soft but tense swelling, obviously prolapsed brain tissue. Dura mater could not be defined immediately over the mass, but towards the posterior edge of the cavity it was easily recognizable. A needle was inserted into the swelling and thick pus aspirated. The dura was then further exposed by removing bone of the posterior border of the cavity. Next, the brain substance was incised, a sinus forceps carefully passed in a backward and inward direction and about 1 oz. of pus was evacuated. No fibrous wall of the abscess could be detected. After further probing, more pus was obtained in a depth of about 2 inches. A rubber drainage tube was inserted into the abscess cavity and kept in position by sutures. The wound was then closed round the tube.

Culture of the pus showed *Staphylococcus aureus*. The coagulase test was negative and it was thought that the organism was probably a skin contaminant.

Soon after the operation, there was a marked improvement in the child's condition. Nausea and vomiting ceased and he became much less lethargic. Locally, there was no pus from the tube. Repeated irrigations with Eusol through the tube were carried out. After one week the tube was removed. At that time there was a very marked improvement in all the cerebellar signs and the VIth nerve palsy was clearing up. Papilloedema was getting distinctly less. On discharge from the hospital, 25 days after operation, there were no neurological signs. The ocular palsies had completely disappeared and the child's behaviour was quite normal. There was still a slight degree of papilloedema. This was still present after a further 3 months. When last seen in *June* 1944, there was no sign of any abnormality, and the fundi were normal.

*Comment*. Prolapse of brain substance can only occur when there is a defect of the covering dura. In this case, there are two theoretical pathways through which brain substance could prolapse, viz. through the incisions made into the dura of the middle fossa at the first operation, or through the inner

## Clinical Records

wall, of the lateral sinus. In view of the cerebellar signs and the fact that the pus came from the region of the posterior fossa, the latter is the most probable, especially as the outer wall of the sinus was necrotic when it was exposed at the first operation. It is very likely that the infective process caused sloughing of the inner wall of the sinus as well, thus producing a defect through which the cerebellum could be protruded. It is clear that this prolapse into the mastoid cavity produced a spontaneous decompression of the posterior fossa, thus largely contributing to the favourable outcome. Apparently the abscess also expanded in the part of the cerebellum which had not protruded into the mastoid cavity causing further rise of intracranial pressure.

The other unusual feature in this case was the sudden onset of a paralysis of both VIth nerves at the same time. Palsy of the VIth nerve is a very common occurrence when the intracranial pressure is raised. But a simultaneous paralysis of both nerves is very rarely seen.

## A CASE OF CEREBELLAR ABSCESS TREATED BY DRAINAGE AND PENICILLIN INSTILLATION

By TOM O. HOWIE (Glasgow)

CEREBELLAR abscess being a comparatively rare complication of chronic mastoiditis is seen only at long intervals. This is the first case which has come under my care since penicillin became available for the treatment of sepsis in Service personnel. I took the opportunity of applying this drug in the case recorded below and thought that it might be of interest to have a record of the operations and progress in this particular instance.

*Record.* Pte. W.P., age 25 years, was admitted to an E.M.S. Hospital under my care on 8.9.44. He complained of pain in and around his right ear for the past 14 days. There had been blood-stained foetid discharge from this ear during the past 2 days.

*Previous History.* He had suffered from a chronic suppurative otitis media in the right ear from the age of 12 years. There was always foetid moisture in this ear although it otherwise caused him no discomfort for many years. He was called up for Service early in the present War but had no active trouble with the ear until May 1942. He was seen by an E.N.T. Specialist and a superior, anterior, attic perforation, with cholesteatoma and foetid discharge was diagnosed. He had had intermittent pain in the ear and had noticed vertigo on bending forward and on quick change in the position of his head. He was examined on frequent occasions and, although radical mastoidectomy was advised, this was never carried out.

*Examination* 9.9.44. There is a chronic otitis with attic disease and cholesteatoma on the right side. Granulations show in the anterior attic wall. Discharge is present in the external meatus. This is foetid and slightly blood-stained. Tenderness is elicited by pressure over the mastoid tip. Both VIIIth cranial nerves are intact although hearing on right is poor. No nystagmus noticed. Temperature since admission has ranged from 97°F. to 102°F.: pulse rate 80-92 beats per minute and respiration rate 20 per minute.

Complaint of pain in the ear and some right-sided headache suggest the necessity for exploration of the right mastoid with exposure of the lateral sinus.

*Operation:* Rt. Radical Mastoidectomy with exposure of lateral sinus—no meatal plastic carried out. *Anæsthetic:*—Pentothal Sodium, G.O. and Ether.

The cortex was sclerosed and acellular lateral to the sinus and antrum. Pus was found in the sinus groove and the sinus was covered with thick felty granulations. It was not thrombosed. A few broken-down cells were found in the retro-facial area extending into the deep tip region. The dura of the

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middle fossa in the tegmen area was exposed and found to be healthy. The radical operation was completed and no ossicles could be found. Cholesteatoma was present in small quantity in the attic area.

The wound was packed widely open with penicillin cream gauze and sulphadiazine, which had been given by the mouth since admission, was continued in 2 gram doses every four hours.

*Further Progress* 10 9 44 Comfortable—no rigors—temperature has dropped to 99.4°F

14 9 44 Packing removed. Considerable fetid discharge. Dressed Sulphanilamide powder on gauze packing. Temperature has gradually dropped to 97.4°F. No complaints. Eating and sleeping well.

18 9 44 Base of wound sloughing—not granulating well. Irrigated Eusol and sulphanilamide packing continued. No complaints. Sulphadiazine stopped. Total dose 48 grams.

27 9 44 Complaints of frontal headache. Temperature, pulse and respiration rates normal. Wound granulating well. No abnormal signs found on examination of central nervous system.

28 9 44 Headache persists—vomited this morning.

29 9 44 Now complaining of occipital headache and pain down back of neck. Vomited again this morning. Mentally alert. Temperature 97°F. Pulse rate has dropped to 52 beats per minute. There is a coarse vestibular type of nystagmus seen when eyes are directed to the right. This becomes fine and rapid on directing the eyes to the left (intracranial type of nystagmus). There is no nuchal rigidity. Kernig's sign is negative. There is no papillary oedema.

*Lumbar puncture* C.S.F. not under apparent increased pressure<sup>1</sup> (Manometer out of order).

Cell Count 28 cells per cmm. Lymphocytes.

Chlorides 780 mgm/100 cc.

Pandy's Test Negative for increased globulin.

Culture Sterile.

30 9 44 Non projectile vomiting this morning. Pulse rate 52.60 per minute. Nystagmus varying in range and direction. Severe frontal pain on flexing head.

*Examination for cerebellar signs* Finger nose test—inco-ordinate on the right side.

Grip—No loss of power in either hand.

Dysidiadochokinesia—found in right hand.

Past pointing—to the right with the right hand only.

Rebound phenomenon—in right arm.

Romberg and walking with the eyes shut—not tested.

No change was found in the reflexes except a slightly delayed right plantar response.

No change noted in the fundi oculi.

A diagnosis of right cerebellar abscess was made.

1 10 44 A tendency to a vertical component was noted in the nystagmus.

## Tom O. Howie

*Operation—Exposure and drainage of an abscess in the right lobe of the cerebellum.*  
*Anæsthesia : —Intra-tracheal G.O. and Ether.*

The post-auricular wound was extended upward and downward and by an incision  $\frac{3}{4}$  in. long carried backward at right angles from the middle of its posterior border. The lateral sinus was exposed up to the knee and down to the region of the jugular bulb. Bone was removed posterior to the lateral sinus until an area of dura,  $1\frac{1}{4}$  in. in diameter over the posterior fossa, was exposed. This was noted to be healthy but tense and slightly bulging. The lateral sinus was delineated. Small iodoform gauze plugs were slipped under the bone at the upper and lower extremities of the lateral sinus to control bleeding. The sinus was opened and found healthy. The outer wall was excised. Trautmann's triangle was thoroughly exposed and a wide-bore needle on a record syringe was passed gently through the dura at right angles and close up to the labyrinth capsule, into the cerebellar substance. Thick yellow pus was found at  $\frac{1}{2}$  in. from the surface and 5 c.c. were aspirated. Sinus forceps, passed through the puncture into the abscess, showed a cavity of  $\frac{3}{4}$  in. in diameter, with a definite wall.

The cavity was gently packed with a long strip of fine dental rubber dam and a soft drainage tube, of fine Southey's type, was laid alongside this into the depths of the abscess cavity and both dam and tube were controlled by suture to the soft tissues. The auricle was sutured forward and the wound dressed with tulle gras. The narrow tube was led through the dressings and secured by a clip to the forehead bandage for penicillin irrigation.

Penicillin locally and intravenous sulphathiazole instituted, 5 gm. given before leaving the operating table.

*Further progress.* 2.10.44. Condition satisfactory. Pulse still 50-60 beats per minute. Temperature 97.6°F. Nystagmus persists—coarse to left and fine and rapid to the right with some obliquity upwards. Mentally alert. B.P. 130/70. White cell count 20,000. Culture from abscess non-hæmolytic streptococci.

Penicillin 10,000 units locally by tube every 2 hours.

Sulphathiazole 1.5 gm. orally every 4 hours.

3.10.44. Pulse still slow and strong. Generalized headache. Persistent variable nystagmus. Slight past-pointing with right hand. Penicillin 10,000 units instilled every 4 hours. Sulphathiazole 1 gm. every 4 hours.

4.10.44. Condition satisfactory. Headache still present. Nystagmus coarse to left, less marked to right. Pulse rate 50-60 beats per minute.

5.10.44. Nystagmus still present. Slightly drowsy.

6.10.44. Brighter to-day. Temperature has remained below 98°F. since 5 days before operation. Nystagmus much less marked.

7.10.44. General condition good—pulse rate has increased to 70 beats per minute. Dressing removed for the first time since operation 6 days ago. Wound healthy. No pus under tulle gras or exuding from the abscess cavity. Compression pads removed from the lateral sinus. 1 inch of rubber dam removed. Culture from abscess shows no streptococci. A few diphtheroids and Gram-negative bacilli showed inhibited growth. 1,000 units of penicillin instilled every 4 hours.

## Clinical Records

- 8 10 44 Satisfactory Pulse rate 72 78 beats per minute  
10 10 44 1½ inches rubber dam removed No pus in wound No nystagmus nor past pointing  
12 10 44 All rubber dam and tubing removed Small strip of rubber dam placed in abscess cleft Penicillin and sulphathiazole discontinued  
Total penicillin locally 520 000 units  
Total sulphathiazole 68 5 gm (5 gm intravenously, remainder orally)  
15 10 44 Pulse and temperature normal—free from headache Trace of vertical nystagmus  
19 10 44 Abscess cavity now only a half inch cleft Rubber dam removed and wound dressed with vaseline gauze  
22 10 44 Pain round right ear and slight frontal headache ,Enlarged and tender glands in right posterior cervical triangle  
24 10 44 There is evidence of a lower motor neuron facial palsy on the right side Angle of mouth supported with wire sling  
28 10 44 Wound clean and granulating No nystagmus Allowed out of bed  
9 11 44 Condition excellent Facial palsy has cleared up  
15 11 44 Post-auricular wound practically healed Patient walking about ward No nystagmus nor residual cerebellar signs

*Comment* After the turbulent course followed post operatively by cases with intracranial abscesses in the posterior fossa with which I have had to deal, this case was a revelation of what one may hope for Penicillin has revolutionized the treatment of sepsis in other areas of the body and has led to a great decrease in mortality in many serious cases Cerebellar abscess is one of our most formidable problems in intracranial complications arising from mastoiditis

This patient had a quiet convalescence and at no time gave rise to anxiety His temperature never rose above normal after drainage of the abscess His appetite returned to normal a few days after operation He slept well and was always co operative

One can presume that the invasion of the cerebellum took place a few days before admission to hospital when his temperature was raised and he complained of severe pain in and around his right ear The intracerebellar pressure became manifest 18 days after exposure of the perisinus abscess The definite abscess wall showed the infection of the cerebellum to be of 2 or 3 weeks' standing

The penicillin was I think, used extravagantly but since it was decided not to disturb the dressing for at least 6 days there was no way of judging the effect on the intracranial sepsis It was surprising to find such a clean wound at the first dressing This compared favourably with the foul sloughing wound encountered at the first operation after a single application of penicillin cream This has prejudiced me in favour of repeated instillation

We were fortunate in striking the abscess cavity at our first exploratory puncture This avoided the risk of producing subsidiary abscesses

There is a strong feeling that all otogenic brain abscesses should be dealt with by the neuro surgeon He would approach them through healthy dura

## Tom O. Howie

and avoid the risk of contamination of healthy brain tissue. He would be able to do an extensive decompression while the abscess matured. The cerebellar abscess has been so treacherous in the past that one has been inclined to follow this course, but if penicillin and sulphanilamide are going to prove such a help as they seemed to be in this case the otologist's approach through the stalk of the abscess may yet remain the route of choice, when he is confronted with such an emergency.

I am indebted to Dr. J. Johnstone, the Superintendent of the E.M.S. Hospital, for his permission to publish this record, and to Dr. Zoé Mackie, my Surgical Registrar, for controlling the penicillin dosage and careful note-taking.

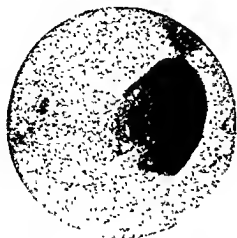


FIG. 1.

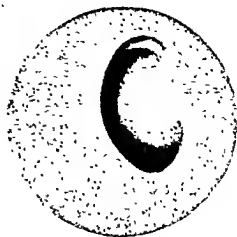


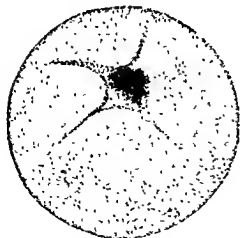
FIG. 2.



FIG 3



FIG 4



/ FIG. 5.

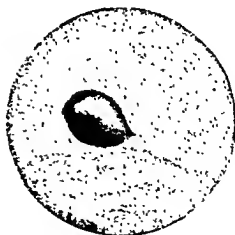


FIG 6.





FIG 7

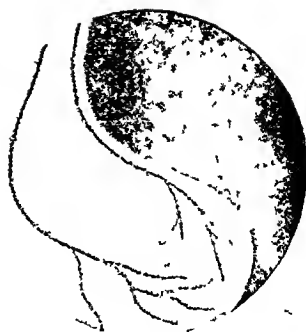


FIG 8

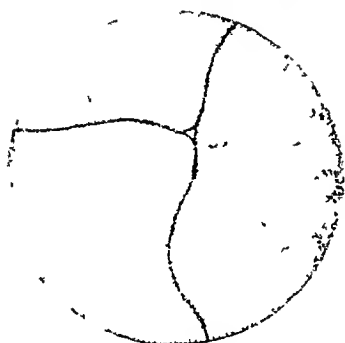


FIG 9



FIG. 10



FIG. 11.



FIG. 12.

# CLINICAL NOTE

## ANTROSCOPY

By DR JUAN BARROILHET (Santiago de Chile)

ANTROSCOPY is a method which allows the inside of Highmore's antrum to be seen through a specially constructed instrument called Stout's antroscope. This consists of a metal trocar and mandril, plus an electric endoscope to be passed through the trocar once the mandril has been removed. An electric battery is also provided.

Pilling & Son in Philadelphia, Pa, U S A make a very good instrument with a splendid optical system which gives a perfect view of the inside of the antrum.

The instrument is used exactly in the same way as when a puncture of the antrum is performed *via* the inferior meatus.

As an anæsthetic, a strong solution of cocaine should be used, painting not only the inferior meatus but also the head of the inferior turbinate. As the instrument is a little thicker than the ordinary puncture trocar, it is necessary, now and then to have to break the inferior turbinate towards the middle line, so as to allow the trocar to pass into the inferior meatus.

The antrum should not be washed out before antroscopy, because it is very difficult to blow out every single drop of fluid, thus air bubbles remain which distort the usual picture and may lead to misinterpretation.

This method is recommended in those cases in which transillumination and X rays do not agree. For instance when transillumination seems normal and X-ray pictures show the presence of a thickened mucous membrane and especially show the presence of polypi. Or the contrary case. It is also recommended when the two above methods agree as to the cloudiness of the antrum, but there is no pus nor drainage of any kind. Obvious sinus suppurations need not be submitted to such a method unless one wishes to examine the mucous membrane just for scientific satisfaction.

The optical system situated laterally, near the tip of the instrument, allows a wide circular fringe of the antrum to be inspected. The further the visualized object the larger it looks, up to the distance of about 2 centimetres. Near details may look small, but any way very much larger than what they really are. One learns how to gauge sizes by examining antra in cadavers.

If we consider the antrum cavity as having a pyramidal form, three walls, angles and triangles will have to be taken into consideration. The base of the pyramid is formed by the lateral nasal wall, and here we will always see the ostium maxillaris. Its form and size are always different but always to be seen. Figs 1 and 2 show the aspect of two normal ostia, one in a cadaver and Fig 2 the one of a healthy sinus.

It may happen that the mucous membrane is only very slightly swollen and the instrument, on entering the sinus and going through the bony wall,

## Juan Barroilhet

may tear the mucous membrane and part of this tear cover the ostium. If this is suspected, the instrument has to be pushed slightly further in. Under the said circumstances, the mucous membrane may also bleed, this soils the optical part of the instrument and the blood accumulates in the lower triangle or alveolar recess and spoils part of the circular picture to be inspected. If the antrum has been washed out, air bubbles are to be seen in the lower part or alveolar recess, as can be seen in Fig. 3.

The tip of the pyramid is the malar recess, which can always be seen very well. Sometimes it will appear as can be seen in Fig. 4, which was the case of a normal cadaver antrum, other times as it appears in Figs. 5 and 6. No. 5 is a case in which the malar recess is surrounded by a number of polypi, the round contour of which was beautiful to see. No. 6 was a normal case which had a tear of the mucous membrane, showing that what was taken for normal was really a slightly swollen membrane, gauged because of its colour and comparison with the depth of the malar recess.

The alveolar recess, when normal is to be seen as several cavities, two or more recesses. In pathologic cases of polypi, we may have pictures such as in Figs. 7, 8, 9 and 10. No. 7 shows a very large polyp on the left hand side, an upper normal piece of mucous membrane and a long tear of the thickened mucous membrane of the inner wall of the antrum. No. 8 shows a beautiful polyp with its vessels, hanging from the orbital wall of the antrum. No. 9 shows three tightly packed polypi. No. 10 shows two hanging polypi.

Other pictures can be had such as Figs. 11 and 12 which show very thickened mucous membranes, sloughy, covered with thick pus.

As for the colours to be seen they vary quite a lot. The normal colour of a healthy antrum is yellowish, because this is the colour of the underlying bone. The mucous membrane is very thin, like tissue paper. Tiny blood vessels can be seen running in different directions. The moment inflammation starts, then the membrane turns red, blood vessels are not to be seen and the whole picture has a dark red colour. Polypi have a gray tint, very different to the surrounding mucous membrane. It is very difficult to mistake a polyp for something else, it is so very characteristic.

Nomishaps have ever been met with, though many cases have been examined. Pain after the operation is very slight. We have never had a hæmorrhage.

*Summarizing:* Antroscopy is a very useful, easy and not dangerous method of examining the interior of Highmore's antrum

Pictures were taken from my assistant Mr. B. Goeck's Thesis for graduation.

## ABSTRACTS

### EAR.

*The Use of Penicillin in Diseases of the Ear.* CAPTAIN CLIFFORD A. SWANSON M.C. (U.S.N.), LIEUTENANT D. E. BAKER, JR., M.C. (U.S.N.R.) *Jour. A.M.A.*, November 4th, 1944, cxxvi, 10.

Infectious diseases of the ear can be effectively treated with penicillin because the anatomic structure of the ear permits the local administration of the drug and because the organisms causing most acute ear infections are in the group considered to be susceptible to the drug. In this study the drug was given either by continuous intravenous injection, intramuscular injection or local instillation.

The drug will not prevent mastoiditis but when surgical intervention is necessary the operation has been supplemented by local instillation of the drug into the mastoid cavity using Florey's method. In 22 mastoid patients the ear became dry in five days and primary healing resulted in 19 patients.

In chronic otitis media penicillin is used locally and forced into the middle ear by means of the pneumatic otoscope. Two cases of chronic otitis media were successfully treated by this method but several others did not respond satisfactorily.

The article has a table and six illustrations.

ANGUS A. CAMPBELL.

### MISCELLANEOUS.

*Penicillin Treatment of Cavernous Sinus Thrombosis.* VICTOR GOODHILL, M.D. (Los Angeles). *Jour. A.M.A.*, May 6th, 1944, cxxv, 1.

The writer reports the case of a 5-year old boy with acute fulminating bilateral cavernous sinus thrombo-phlebitis and with a positive blood culture yielding hæmolytic *Staphylococcus aureus*. This followed furunculosis of the central part of the forehead.

The patient was treated with sulphathiazole and heparin for a week during which time the disease progressed rapidly. With penicillin treatment there was an apparent dramatic response and within seven days the child became afebrile although the blood culture still remained positive. At the end of the second week with penicillin the patient was able to leave the hospital.

The article is illustrated.

ANGUS A. CAMPBELL.

*Cold Vaccines and the Incidence of the Common Cold.* LEMUEL C. MCGEE, M.D. (Wilmington, Del.), J. E. ANDES, M.D. (Morgantown, W. Va.), C. A. PLUME, M.D. (Succasunna, N.J.) and S. H. HINTON, M.D. (Parlin, N.J.). *Jour. A.M.A.*, February 26th, 1944, cxxiv, 9.

This study concerns the administration of cold vaccines to men and women between the ages of 19 and 68. It covers the October to April period of 1941-42 and 1942-43. Five geographical locations are represented.

## Abstracts

Prophylactic medicines used represented two cold vaccines for hypodermic use and three for oral use. No effort was made to use vaccine for treatment of the acute cold. Subjects were selected at random and control studies included the use of placebos orally and subcutaneously.

No clearly evident protection against the common cold and its related acute respiratory infections could be demonstrated by this clinical trial.

The article has a table and a bibliography.

ANGUS A. CAMPBELL.

*Uses of Penicillin in Diseases of the Nose and Throat.* CAPTAIN F. T. PUTNEY, M.C. (A.U.S.). *Jour. A.M.A.*, November 4th, 1944, cxxvi, 10.

The writer used penicillin combining local and systemic administration in overwhelming infections and complications of ear, nose and throat diseases when life had been endangered. Acute conditions have afforded the most gratifying results while in chronic diseases the response has been hard to evaluate.

In osteomyelitis of the skull penicillin has not supplanted surgical procedures but helps materially in combating the disease. The optimum time for operative measures in acute spreading osteomyelitis is during the period in which the infection has been checked by penicillin. Brain abscess, extradural abscess and orbital cellulitis have occurred as complications of osteomyelitis without apparent bearing on the response to the drug. In chronic osteomyelitis of the frontal bone it is possible to obtain healing under penicillin therapy without resorting to extensive surgery and a thorough trial of penicillin lasting over several months may be necessary.

ANGUS A. CAMPBELL.

# The Journal of Laryngology and Otology

(Founded in 1887 by MORELL MACKENZIE and NORRIS WOLFENDEN)

July 1944

## MEDIASTINAL EMPHYSEMA

By R. L. FLETT (Derby)

J. W., boy aged 10, referred for removal of tonsils and adenoids. There had been so many attacks of acute tonsillitis, and the tonsils appeared to be so adherent that instead of a guillotine operation being performed, they were removed by dissection. The adenoids were removed by the La Force type of adenotome. The operation was performed by my house-surgeon under my supervision, and looking over his shoulder, everything seemed to go on quite normally, and in the light of subsequent events, there was no aspiration of blood. (May 28th, 10 a.m.)

Three hours later free bleeding occurred from the adenoid area. There was a large clot hanging from the nasopharynx, this was removed and the patient propped up. Bleeding ceased after one hour. His condition during the night seemed quite satisfactory considering his reactionary hæmorrhage. His pulse rate was taken hourly and varied between 140 and 110.

However, at 7.30 a.m. on May 29th he complained of pain in the front of the chest and upper abdomen and his pulse rate rose to 150.

At 8.30 a.m. he became cyanosed with marked respiratory distress and on examination there appeared to be bronchial breathing with loud moist râles over both bases. Temperature remained normal and pulse rate still 150.

At 9.30 a.m. surgical emphysema appeared in the base of the neck, at the angles of the jaw, over the upper part of chest, and in the axillæ. At 10 a.m. I saw him and his condition was now critical, cyanosed, semi-conscious, difficulty in breathing (oxygen was being administered) and restless at times. His pulse rate was now up to 160, temperature still normal and respirations up to 60. The surgical emphysema at the time could not be explained, but his respiratory signs seemed to point to some bronchial obstruction.

An X-ray film was taken with the patient lying on his mattress still propped up with pillows, as this position seemed to cause least respiratory

embarrassment. His pulse now could not be counted, and had become much weaker. The film (fig. 1) showed air in the mediastinum and neck, and the heart pushed over to the left side. It was decided therefore that there was definite ballooning of the right lung by a valvular obstruction to the right bronchus. This ballooning had resulted in rupture of an alveolus and spread of the air through the interstitial tissue of the lung to the hilum and mediastinum.

He was transferred immediately to the operating theatre, still propped on his mattress on a trolley, and still having oxygen. There, a laryngoscope was inserted without any difficulty, there was a small amount of dark blood and mucus coming from the nasopharynx. A bronchoscope was passed into the trachea; a suction tube was attached and also a tube from an oxygen cylinder attached to the anæsthetic tube. This improved his colour slightly. The lower part of the trachea was occupied on the right side by some blood clot which continued down into the right bronchus. This was removed by a suction tube and a good deal of mucus with it. The right bronchus then was clear, and the left one also was cleared of bubbly mucus. His colour was now much better and pulse now countable at 150. Both bronchi and trachea seemed narrower than usual and there was not the usual contraction and relaxation of the posterior muscle with respiration. This may have been due to his mediastinal emphysema. On removing the bronchoscope, his general condition was good, no cyanosis, pulse rate 150, respiration rate 32, he was able to speak and in fact asked for some water. This was given, naturally taking care to see that he swallowed it properly without aspirating any. Owing to his surgical emphysema, his swallowing was slow and difficult.

In the evening his temperature went up to  $103.4^{\circ}$ , pulse 160, and respiration 35, and the next morning again, temperature  $103.4^{\circ}$ , pulse 150, and respiration 45. He continued with gradually smaller evening rises of temperature for the next five days, and his pulse gradually became slower to a rate between 80 and 90 (fig. 3). He had some slight cough, rather a cough of irritation and with no sputum. His surgical emphysema gradually receded first in the axillæ and then at the angles of the jaw, and last, at the base of the neck. An X-ray of his chest was reported normal on June 12th, 15 days after his bronchoscopy (fig. 2).

Some concern was caused on June 10th and 11th by a rise of temperature, but this was explained by the appearance of some small and tender glands in the anterior and posterior triangles of the neck. He was discharged from hospital on June 21st.

The case described above was felt to be rather a rare complication of bronchial obstruction, a condition which does not commonly follow removal of tonsils and adenoids. A search of the literature has not found a similar case in this country.



FIG. 1





FIG 2



pneumothorax, or into the interstitial tissues, to result in mediastinal emphysema (McCrae.)

As regards the surgical pathology of the mediastinum with relation to emphysema, a number of interesting facts have been discovered by various workers after artificial pneumothorax. In view of their importance in connection with endoscopy, it has been thought desirable to incorporate them with the report of the case.

Nitsch (reported by Ehrenburg) was the first to announce that the mediastinum as a septum between the two halves of the thorax presented two weak areas. 1. Anteriorly at the level of the second and third cartilages. Here two thin pleural sheets may sometimes be found fused together, but in any case, there is very little support in the anterior mediastinum from the upper margin of the manubrium to the region of the third and fourth ribs. This is the previous site of the thymus, and is occupied only by loose connective tissue. 2. Posteriorly between the spine and aorta at the back and the œsophagus and heart in front. With regard to emphysema, these are two sites where distension of the mediastinum may occur, and this is well shown in the first X-ray picture, especially just above the diaphragm. Vinson and Moersch note the appearance in one of their cases, as if there were air in the pericardial cavity, but it seems more likely that one of these weak areas was distended with air.

Ehrenburg has described also two septa which are situated in the mediastinum and which form in the adults, a tight membrane. Herzog (reported by Ehrenburg) states that in childhood these septa contain less elastic tissue and are more easily injured, especially in whooping cough. Here with perhaps plugs of mucus more in one lung than the other, pressure during coughing may not be equal in the two halves of the thorax.

There is one septum on the right side of the mediastinum applied to the upper part of the superior vena cava. The other is on the left side, running from the arch of the aorta to the left border of the upper part of the pericardium. This left septum limits the distension of the mediastinum in this region, and is shown in the first X-ray picture. Owing to the distension of the right lung, the right septum is situated behind the sternum.

Once air has arrived in the mediastinum, it distends first the weak areas described by Nitsch, but is limited by the septa described by Ehrenburg and the mediastinal pleura. Then with every inspiration, air is pumped into the mediastinum, while some can get out with expiration. (Baskin.)

Closure of the glottis by cough, forces more air in from the blown-up lung. Having filled the mediastinum, air may spread downwards below the diaphragm along the course of the aorta, œsophagus, or inferior vena cava, causing emphysema retroperitoneally. More commonly it spreads upwards along the connective tissue sheaths of the branches of

## Mediastinal Emphysema

the aorta into the neck, axillæ, and in one case (Vinson and Moersch), into the forearm. It may also dissect a passage from the trachea to the floor of the mouth, extending under the base of the tongue which becomes raised. Sewell reports a case (Šercer and Peičič) where there was emphysema of the mediastinum anteriorly and posteriorly, and the lining of the trachea was distended by air. This was found at post-mortem and must have been due to air tracking up under the mucus membrane of the finer bronchi. Clerf notes also that the trachea was narrowed and retropharyngeal wall pushed forward in his two cases.

As regards the cause of the obstruction in this case, blood clot was aspirated to form a valvular obstruction. In one case (Vinson and Moersch) a paper clip must have caused an injury to the wall of the trachea or bronchus in such a way that a valvular flap was formed, opening in inspiration and closing in expiration. The other cases (9) were of foreign bodies of the vegetal type (Clerf). Baum also reported four cases of vegetal foreign bodies, two of which had mediastinal emphysema. These patients were also *in extremis*, cyanotic with pallor of the upper lip and pulse uncountable. One of Vinson and Moersch's cases was also in a critical condition. This case had surgical emphysema from the mediastinum to the forearm. In both these cases there was no possibility of taking X-ray films in inspiration or expiration so that in the picture shown there is not the contrast between the two lungs.

Baum who reported on cases of laryngo-tracheo-bronchitis, included two foreign body cases with mediastinal emphysema, and noted in the general symptoms of all his cases a peculiar type of cyanosis. They were all in a state of collapse, and were not so much blue as pale, and even in the infective cases had a low temperature. He stated this was due to lack of oxygen in the blood. Some of his cases required tracheotomy and further suction, or repeated bronchoscopy.

The remainder of the cases reported, do not appear to be in anything like this urgent condition, but besides subcutaneous emphysema showed frequent wheezing perhaps shortness of breath on exertion and no cyanosis. The other symptoms were due to the subcutaneous emphysema, slight pain beneath sternum and in neck, slight difficulty in swallowing, and crackling when swallowing or moving the jaw.

In the cases following the formation of an artificial pneumothorax, only local effects due to the subcutaneous emphysema were complained of (Parfitt and Crombie). One of Ehrenburg's cases complained of dyspnoea and another of dizziness. In this type of case all the symptoms disappeared in thirty-six hours.

The difference in the general condition of the patients, one type of patient collapsed and the other in good general condition, depends I think, not so much on the subcutaneous emphysema or mediastinal emphysema, but on the amount of displacement of the whole mediasti-

num. In both my case and that of Vinson and Moersch, the right side of the arch of the aorta was distinctly visible in the skiagrams to the left of the sternum. This displacement therefore depends on the amount of ballooning of the lung. In none of the other cases reported, was the displacement as large as that, and in none of the others was the patient as ill.

Jessop has studied mediastinal emphysema following external injuries of the thorax, and states that the whole circulatory system is affected by compression of systemic veins causing a drop in blood pressure, and of pulmonary veins causing congestion of the lungs and pulmonary oedema. The arteries and trachea are not affected by the increased pressure. In one case only was the heart directly affected. It is to be expected in these cases where the mediastinum is excessively displaced, that the increased pressure on the systemic and pulmonary veins, would cause further circulatory difficulties. This is thought to be the cause of the cyanosis, collapse, and rapid respiration rate.

From the point of view of prognosis Imperatori's case seems to be most important. The patient two days after choking on a peanut, developed subcutaneous emphysema. Bronchoscopy was performed and the peanut removed. The subcutaneous emphysema diminished very little and the patient died ten days after bronchoscopy.

At the post-mortem a purulent pericarditis was found, and thick creamy pus in the superior mediastinum along the course of the great vessels and trachea. There seemed to be therefore a constant amount of air in the mediastinum supplying the subcutaneous emphysema. In the tissues of the neck this air is constantly being absorbed and therefore air or gas must have been supplied either by the bacteria in the mediastinum or from the leaking alveolus in the lung being kept open by infection. This latter, I think, is the more likely. For this reason therefore, if the subcutaneous emphysema continues for longer than 36 hours, the presence of mediastinal suppuration must be suspected.

In the case reported, the patient was very ill for four days afterwards, and his temperature did not settle for ten days. Forbes in his case states that after removal of a peanut the emphysema disappeared but a stormy ten days followed, resulting in recovery. Vinson and Moersch had one case which required tracheotomy after the bronchoscopy and was put in an oxygen tent afterwards. The case in which the air extended to the forearm was in a critical condition before bronchoscopy and was also put in an oxygen tent. This case, however, was kept in the Mayo Clinic for only four days, whereas my case remained in hospital for three weeks.

In traumatic cases Gatellier has suggested an operation to reduce the pressure inside the mediastinum. Formerly in the occurrence of mediastinal emphysema after an injury to the thorax, thoracotomy had been

## Mediastinal Emphysema

performed, also puncture of the chest by trocar or incisions below the clavicle Tiegel's method was a four inch incision made in the supra-sternal notch down to the trachea, and continuous suction over the wound by a glass bell for 5 days

Gatellier now recommends opening up of the fascial planes in the neck in front of the trachea and on both sides of it, to behind the œsophagus He thinks it applicable not only to traumatic cases, but also to this complication in children following whooping cough and bronchopneumonia In these latter cases, however, there is usually some bronchial obstruction as the primary cause, and it would seem better to deal with that by bronchoscope and suction

Besides the question of mediastinal emphysema, there remains the condition as a complication of removal of tonsils and adenoids, or rather, of removal of adenoids Reactionary hæmorrhage had occurred from the nasopharynx, and it is likely that during the night the clot in the nasopharynx had been loosened and was aspirated In the case of bronchial obstruction, especially of the check valve variety, there is a latent period or symptomless interval, and in this case, it is again possible that the blood clot was aspirated in the early afternoon, and yet did not cause symptoms until the next morning It may be taken as definite that aspiration did not occur at the time of the operation

The loosening of a clot in the nasopharynx is a process much less noticeable to the patient than if it had occurred from a tonsillar area The patient's nasopharynx is already obstructed by blood clot, and this can quite well be aspirated without the patient noticing it I have found recently that reactionary hæmorrhage from the nasopharyngeal area is more common after using an adenotome than after an adenoid curette The hæmorrhage has never been excessive, has never caused anxiety, and its occurrence in these few cases has been outweighed by the efficient clearance of the nasopharynx I should like to suggest that aspiration of blood clot is more likely to occur from the nasopharynx than from the tonsillar area From the latter area, blood is more easily swallowed It follows therefore (I suggest this tentatively, from the observation of this one case) that aspiration of blood and lung abscess following removal of tonsils and adenoids might be due not to carelessness during the operation, but to aspiration from the nasopharynx during the post-operative period

Cases of this type may be divided into three degrees, according to the amount aspirated and the degrees of obstruction 1 Massive obstruction causing sudden asphyxia and death or urgent symptoms, as in this case, requiring immediate surgical attention 2 Smaller amounts aspirated but causing obstruction of a branch bronchus and going on to lung abscess These are the cases that have been reported in America in large numbers, and have been put down to several possible

causes, sitting position of patient during operation and embolism from tonsillar area. Another minor factor which may be noted is that the adenotome is used more commonly in America than the curette, which is more widely used in this country. I have not, however, been able to obtain any information about post-operative hæmorrhage from adenoids.

3. Minor degrees of aspiration may lead not to lung abscess but to fibrosis of lungs or bronchiectasis. I have had this occur in one case which had a reactionary hæmorrhage from the nasopharynx. No aspiration was detected but the patient was ill for three weeks after the operation, and since then, the area causing liability to infection such as chills and colds, has been transferred from the throat and nasopharynx to the chest.

### SUMMARY

1. A case is described in which after removal of tonsils and adenoids; reactionary hæmorrhage occurred from the nasopharynx, followed in 24 hours by mediastinal emphysema.
2. This was found to be caused by a check-valve bronchial obstruction and relieved by bronchoscope and suction.
3. A short discussion of the pathology and symptoms is given, comparing this case with others reported.
4. Post-operative aspiration of blood from the nasopharynx is considered as a possible common cause for lung abscess following removal of tonsils and adenoids.

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## CLINICAL RECORDS

### LARYNGO TRACHEAL DIPHTHERIA IN AN ADULT REQUIRING TRACHEOTOMY COMPLICATED WITH PREGNANCY, WITH RECOVERY

By J M KENNEDY (Sheffield)

LARYNGEAL diphtheria in an adult causing respiratory distress is a very rare and serious complaint. This is the only case I have seen in 15 years amongst 17,000 cases of diphtheria admitted to Lodge Moor Hospital. The instance of laryngeal diphtheria in adults is so rare that only a few have recorded the condition in these isles. Rolleston (1916) records only 4 cases of laryngeal diphtheria in adults of which 3 were fatal among 1,156 cases of laryngeal diphtheria between 1899 and 1915 during which period a total of 11,313 diphtheria patients were admitted. From 1916, when Rolleston (1940) wrote on the subject, until 1940, when he again reviewed the condition, he was only able to collect 12 cases of which only 2 occurred in Great Britain the remaining 10 on the Continent. Begbie (1861) is the only other British writer who has recorded the condition when he read a paper before the Medico Chirurgical Society of Edinburgh in 1861 on a fatal case in a man aet 39 years. Caneva (1852) drew attention to pregnancy especially in primiparae as a predisposing cause of croup. Of the 5 cases on which his thesis is based 3 occurred in primiparae in the last weeks of pregnancy. It is indeed remarkable how large a proportion of the recorded cases of croup in the adult have occurred in pregnancy both before and since the publication of Caneva's work. Colarusso (1935) records the rarity and high fatality of diphtheria of the larynx in adults. Of 15 000 cases of diphtheria admitted to the Conigno Hospital, Naples there was only 1 case of laryngeal diphtheria above the age of 15 years. Goodall (1928) records 856 women between the ages of 15 years and 40 years admitted with diphtheria to the Eastern Hospital during the years 1892 to 1907. In none was the larynx affected. Troiser (1922) records two cases of diphtheria of the larynx in adults—a woman aged 50 years, a dyspnoea attack necessitating tracheotomy, death following a few minutes after the operation. Autopsy revealed membrane extending from the vocal cords to the bifurcation of the trachea. The second, a woman aged 23 years, laryngotomy was performed at once and was followed three hours later by tracheotomy with recovery. Veillon (1909) records a successful case of tracheotomy in a woman aet 20 years in whom diphtheria angina had been left untreated for 10 days. That croup in the adult is the appanage of grave diphtheria they indicate by the following aphorism: "In the child little diphtheria will produce much croup while in the adult much diphtheria is needed to cause only a little croup." Trousseau



## J. M. Kennedy

(1861) states in the adult who has a relatively wider opening to the larynx than the child, the calibre of the trachea being also larger, the air finds sufficient passage even when the walls of these channels are becoming covered with membrane. When the symptoms of croup become marked diphtheria has had time to pass deeply into the ramifications of the bronchi. Rolleston (1929) states that the condition as a rule is much more serious than in children for, by the time that the symptoms of croup have become marked in the adult, the diphtheritic process has extended deeply into the ramification of the bronchi, severe dyspnoea is absent or of late onset, whereas there is a marked degree of prostration. As Rolleston says, had a routine laryngoscopic examination been made in every case of faucial diphtheria in the adult, the percentage of laryngeal diphtheria would undoubtedly have been higher. Brown (1940) recorded a case of laryngeal diphtheria in a female aged 72 years in Kingston, Jamaica, when he asked for replies the only reply was from Rolleston stating his experience.

Among the victims of croup may be mentioned the following. *George Washington* (1799). His death occurred with startling suddenness, A neglected cold developed into a malignant type of cynanche trachealis with which the limited medical knowledge and skill of the time were unable to cope. With his physical strength sapped by mistaken blood-lettings he fought a losing battle for nearly 24 hours. He died at 11.30 a.m. on *Saturday, December 14th, 1799*.

*Princess Alice* (1878), the third child and second daughter of Queen Victoria. On *November 15th, 1878*, her youngest child, the Princess Mary, died in her fifth year from diphtheria, an epidemic which had for eight days prostrated nearly every member of the grand-ducal family. The mother already worn out by her ministrations to her husband and children caught the infection and died after a few days illness of respiratory embarrassment. "My Lords", said the Earl of Beaconsfield in addressing the House of Lords upon the occasion, "there is something wonderfully piteous in the immediate cause of her death. The physicians who permitted her to watch over her suffering family enjoined her under no circumstances whatever to be tempted into an embrace. Her admirable self-restraint guarded her through the crisis of this terrible complaint in safety. She remembered and observed the injunctions of her physician. But it became her lot to break to her son, quite a youth, the death of his youngest sister to whom he was devotedly attached. The boy was so overcome with misery that the agitated mother clasped him to her arms and thus she received the kiss of death. She died on *December 14th, 1878*.

*The Ex-Empress Josephine* (1814). At her residence, Malmaison, on the *May 24th, 1814*, Josephine was obliged to receive the Russian Grand Dukes. As she seemed to be suffering from a slight cold, her daughter, Hortense, urged her to retire to her room. The following morning as Hortense entered her chamber at an early hour she found her mother (Josephine) breathing with difficulty. Greatly alarmed she summoned the court physician who agreed with her that her mother was suffering from more than a common cold and assented to a consultation. On *May 27th* Josephine's condition was so alarming that Hortense decided to send to Paris for assistance. A consultation was held and it was declared that the Empress was suffering from a dangerous

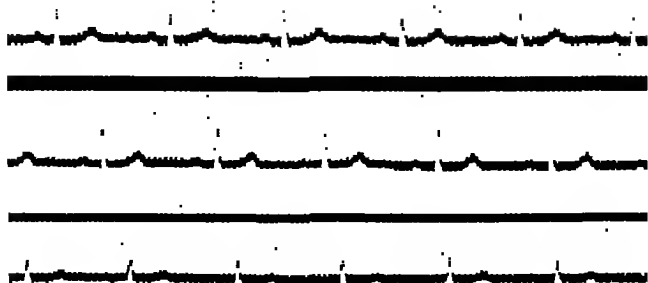


FIG. 1.  
Electrocardiogram 12 days after onset.

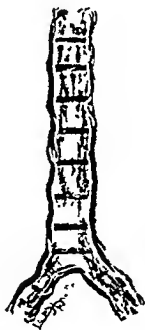


FIG. 2.  
Sketch of tracheal cast.



## Clinical Records

attack of quinsy, but, although the physicians feared it was too late for remedies to be of avail, they concealed their worst fears from the watchers and awaited in anxiety the result. Josephine uttered no complaint and did not appear to suffer, except from increased difficulty of breathing. With Eugene and Hortense by the Empress's bedside, the loving Josephine endeavoured to stretch forth her arms to embrace her children. It was with great difficulty that she could speak to them. She died at noon on *May 29th, 1814*, from an illness of less than one week.

When we realize that the bacillus of diphtheria was first described by Klebs of Zurich in 1855 and that it was only in 1826 that the work of Bretonneau, Trousseau and the French school that put diphtheria on a sound clinical foundation and established its specificity, there can be very little doubt that the deaths of Princess Alice, George Washington and Josephine were brought about by laryngo-tracheal diphtheria.

### CASE REPORT

Mrs C, act 23 years, pregnant 6 months

*Sunday, January 23rd, 1944* Felt out of sorts as if developing a cold in the throat

*Monday, January 24th, 1944* No improvement and in the evening accompanied her husband (H M F home on leave) to the "Local" but was unable to drink. She did not feel well and returned home and went to bed.

*Tuesday, January 25th, 1944* Remained in bed, breathing embarrassed, condition worse. Doctor called in and "Tablets" and medicine prescribed which the patient was unable to swallow. Towards evening there was loss of voice.

*Wednesday, January 26th, 1944* Her condition much worse, aphonia, dysphagia, unable to swallow anything, dyspnoea, breathing very difficult coughing up thick, blood stained phlegm. No sleep, sitting up in bed to get her breath.

*Tuesday, January 27th, 1944* Condition one of anxiety, unable to swallow even the juice of an orange, no voice. Very troublesome cough and urgent dyspnoea. Doctor summoned and immediate removal to Hospital advised. The Hospital was notified by her doctor just after 9 p.m. as an urgent case of laryngeal diphtheria. An ambulance was dispatched forthwith and she was admitted to Hospital at 10 p.m. Seen on arrival in the ambulance her condition was undoubtedly urgent. Her colour was congested, very tight croupy troublesome cough, complete absence of voice. Very distressed breathing was not able to lie down on the ambulance stretcher. Felt easier sitting up, she had a very marked anxious expression. Inspection of her throat revealed mucopurulent material along the posterior faucial pillars and small points of membranous exudate on the posterior pharyngeal wall, tonsils swollen and injected but quite clean. Epiglottis swollen and oedematous and yellowish white membrane present over the posterior surface and extending along the arytenoid epiglottic folds. There was tender cervical adenitis with cellular oedema. She was immediately given 60,000 units diphtheria antitoxin intramuscularly and placed in an atmosphere of mentholated steam and her condition closely



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watched By 11 p m one hour after admission her condition was most grave, very poor colour, lips cyanosed, rapid running pulse I decided to do a tracheotomy and she was taken into the theatre As she was very restless and excitable morphine sulphate gr  $\frac{1}{4}$  was administered with intentions of doing the tracheotomy under local anaesthesia as I did not consider her a good risk with a general anaesthetic and she was certainly too restless and excitable to attempt without any anaesthetic Within a few minutes of the injection of the morphine her condition became much improved with good colour, breathing easier and no restlessness so much improved that interference or operation was certainly not indicated A good view of the larynx was now easily obtained and showed a swollen and very oedematous larynx with extensive membrane A swab was taken which on direct examination showed typical C diphtheriae She appeared so much better that she was returned to the Ward looking very comfortable and rested well until 2 a m (4 hours after admission) when her condition suddenly and rapidly became most urgent She was rushed to the Theatre in a semi comatose condition her colour very cyanosed pulse feeble and thready and extreme dyspnoea Statim tracheotomy was performed with no anaesthetic whatever There was not the slightest resentment or effort made during the operation she just lay helpless and motionless Some free venous haemorrhage was encountered and the trachea was quickly incised and a large tracheotomy tube introduced There was not the immediate relief, however, which one experiences on opening the trachea of a croup, and even when the tube was inserted her breathing was very shallow and irregular and she just lay helpless with absent corneal reflex From her condition it was evident that the obstruction was lower down I removed the tube and introduced long tracheal dilators a dry sterilized feather being passed quickly down the trachea for some 6-8 inches and quickly withdrawn This had the desired effect which stimulated a cough reflex and the coughing up of a large cast of membrane which was caught as it presented itself at the tracheal opening and was withdrawn but unfortunately, broke on removal (vide sketch) Coughing was encouraged and large pieces of blood stained membrane were coughed out of the wound Her condition now rapidly improved breathing deeply and regularly colour was excellent and pulse full and regular she now opened her eyes and took an interest in her surroundings A further 40 000 units of diphtheria antitoxin were given intravenously She was taken to the Ward and rested for short intervals frequently coughing up fragments of membrane At 3 30 a m (5½ hours after admission) she complained of and indicated abdominal pain Uterine contractions were quite definite and occurring every few minutes the foetal heart was not audible A small show of blood stained mucus was present from the vulva Morphine gr  $\frac{1}{4}$  was given when the uterine contractions appeared to be less frequent and not so intense her colour remaining very good with strong full pulse At 5 a m morphine gr  $\frac{1}{4}$  was repeated

*Friday, January 28th 1944* At 9 30 a m she was seen by Dr Clancy, no foetal heart heard and uterine contractions occurring regularly Progestin 5 units with morphine gr  $\frac{1}{6}$  was given every 4 hours At 5 p m she called for the B P passed urine to be followed by labour Membranes intact and protruding from the vulva which were ruptured and followed by a speedy and

complete delivery of a still-born foetus, complete with membranes and placenta. Ergometrine 0.125 grm. intravenously and Ergometrine 0.5 grm. intramuscularly was administered after the delivery which resulted in immediate contraction of the uterus with very little hæmorrhage. Her pulse and colour were very good and there was little or no post-partum shock.

*Saturday, January 29th, 1944.* At 3 a.m. the tracheotomy tube became obstructed with tenacious, purulent material. The tube was removed and cleansed and the patient appeared more comfortable. A few hours later at 6 a.m. she was again in difficulty with purulent material blocking the tube which, at this stage, I removed altogether and she was coughing up the material satisfactorily through the open tracheal wound. At noon there was a rise in her temperature and pulse (vide chart) and she was somewhat irritable and restless and taking fluids most unwillingly. Her respirations were increased and small areas of consolidation were present over the left lung. 2 grm. Thiazamide in 50 c.c. 20% Glucose was given intravenously and this was repeated in the evening. Sleep was encouraged by giving Chloral Hydras 40 gr. in 2 oz. normal saline per rectum.

*Sunday and Monday, January 30th and 31st, 1944.* On the following days Sunday and Monday, 2 grm. Thiazamide in 50 c.c. 20% Glucose was given intravenously three times a day and the Chloral Hydrate repeated in the evenings.

*Tuesday, February 1st, 1944.* On the Tuesday, the fifth day following her tracheotomy, there was a dramatic improvement in her condition. She had a good natural colour, her pulse full and steady and she was able to take some light diet and was taking a keen interest in herself and her surroundings.

*Wednesday, February 2nd, 1944.* The following day, Wednesday, the wound was clean and closing up satisfactorily and less mucus was being coughed up, her heart was quite good and her blood pressure 110/70. No further drugs were given and sleep was natural, good and refreshing. Her progress henceforth was most satisfactory and an Electrocardiogram taken twelve days later showed a normal record. Her convalescence was uneventful, at no time was there the slightest suggestion of paralysis, her voice was slow in returning but returned full and strong. She was discharged from Hospital on *March 25th, 1944*, the 63rd day of illness, having been in hospital 58 days. She was then quite fit and strong, having had no post-diphtheritic complications.

I understand that six weeks after her discharge from hospital, she was examined by the medical board of the Ministry of Labour and considered a fit person for direction to full-time employment.

The diphtheria bacillus from this case proved virulent for guinea-pigs; Type intermediate.

## SUMMARY

A case of laryngeal diphtheria occurring in a female adult with pregnancy which necessitated tracheotomy, followed by delivery of a 6 months foetus, complicated by broncho-pneumonia, treated with 60,000 units diphtheria antitoxin intramuscularly and 40,000 units intravenously and 16 grm. Thiazamide intravenously, with no complications and complete recovery.

# Clinical Records

I wish to express my appreciation to Dr L C D Hermitte, Pathologist, Royal Infirmary, Sheffield, for his sketch of the tracheal cast, to Dr. W. Clancy, Obstetrician, City General Hospital, Sheffield and to my colleagues Drs Leonard Meagher and Fitzgerald for their help and assistance

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## A CASE OF SENILE TUBERCULOSIS OF THE MAXILLARY ANTRUM

By W. STIRK ADAMS (Birmingham)

THE patient was a man aged 78 who had spent his working life as a Brass Founder. His first nasal symptom occurred three years previously when he developed a right unilateral nasal discharge, and eighteen months later when he came under the care of a colleague since deceased, he was found to have dental caries in his right upper jaw, a dermatitis of his upper lip, and both antra dull on transillumination.

A proof puncture of both antra revealed pus on both sides, and as in spite of further proof punctures the infection persisted, an intranasal antrostomy was carried out in *March 1944*.

In *September 1944*, the patient told me he had had frontal headaches every day and lasting most of the day during the previous four months (of a great severity). A fortnight earlier he had developed pain in the right upper gum of an intense type, and a swelling had appeared in the right lachrymal sac region. For three weeks he had been confined to bed at home, and for the previous week had been unable to sleep because of the severity of the pain. His doctor told me that during the past fortnight he had threatened self destruction if no relief could be given from his pain.

On examination he appeared a well developed, physically robust man of alert intelligence; upper and lower eyelids on the right side were red and oedematous, and could not be opened. The inflammatory swelling extended medially to the ridge of his nose, and downwards to his right cheek. A yellow nasal discharge dripped from his right nostril, and his upper lip was excoriated. There was no swelling in his mouth, and no obstruction to his right nasal passage. He was apyrexial.

The history of three years' unilateral nasal discharge, of his headaches during the previous four months, culminating in intense facial pain during the previous fortnight, associated with the inflammatory swelling in the lachrymal region suggested that the condition was due to a new growth in his right maxilla which had perforated through the lachrymal region to his face.

He was admitted to the Queen Elizabeth Hospital on *September 24th, 1944*, and radiographs taken then showed no evidence of bone destruction in his right maxilla, but both antra were opaque.

Biopsy to establish the diagnosis was carried out through a sublabial incision opening his right antrum. After dividing the soft tissues, a subperiosteal collection of pus was opened in the lachrymal region, while the anterior face of the maxilla was intact. The bone was brittle and in the cavity of the antrum a very pale jelly-like membrane lay in folds occupying about half its lumen. Portions of this membrane were removed for examination and the incision closed.

## Clinical Records

Professor Haswell Wilson reported on *October 2nd, 1944*, that the microscopic appearances were those of *senile tuberculosis*.

An X-ray of his chest in *October 1944*, revealed calcified areas in both lung apices, diagnostic of an old tuberculosis.

The patient made a good post-operative recovery, and lost his pain. Treatment by short wave therapy assisted rapid resolution of the swelling of his face, and he was returned home for treatment under the Anti-Tuberculosis Department of the Public Health Service of the City.

### COMMENTARY

The march of events in this case suggests that a tubercular invasion presumably blood-borne, occurred in his right antral mucosa three years previously, and though clinically a diagnosis of malignant new growth appeared correct, on reflexion the length of the history and the absence of maxillary destruction as shown by X-ray should have raised doubts.

This condition appears to be of considerable rarity, and the case is presented for publication for this reason. It adds one more condition to the few where pain of unbearable severity is the most prominent symptom. The most appropriate comment on its rarity was made by that acute physician Dr. I. Z. Lloyd, of Bordesley Green, the patient's own adviser, who when I told him the diagnosis replied that the only similar case he had met in his professional life was at his final examination 50 years previously.

## A CASE OF MENINGISM PRODUCED BY THE EFFECTS OF BLAST ON THE EAR

By J. A. SEYMOUR-JONES (Capt. R.A.M.C.)

To the otologist working in a part of active operations, cases of rupture of the tympanic membrane as the result of blast are no rarity. The case cited below however, presents some unusual and initially misleading features and may therefore be considered worthy of record.

Private V., aged 21 years, was admitted to a Field Ambulance Advanced Dressing Station on *September 17th*, 1944 at 14.15 hours, a mortar bomb having exploded near him at 10.30 hours. He was observed to have a headache and to be bleeding slightly from the left external auditory meatus. He was transferred to the Main Dressing Station of another Field Ambulance where, on examination, no injury was detected apart from a rupture of the left tympanic membrane. He was, however, rather dazed and restless, and a diagnosis of exhaustion was made. He was evacuated to a Casualty Clearing Station as a stretcher case.

When I examined him the same evening I found a small, round, postero-inferior perforation of the left tympanic membrane with a scanty serous discharge. The right tympanic membrane appeared normal apart from a small blood clot lying on the surface posteriorly. He presented many features of a patient "exhausted" as the result of battle stress, and was referred to a psychiatrist who on *September 18th* stated that he complained of a headache, of staggering and feeling weak, and that there was a considerable conscious exaggeration of his condition. A diagnosis was made of an acute anxiety hysterical reaction in a non-battle-hardened patient.

Routine sedatives were prescribed. On *September 19th* he was observed to be much more settled and well sedated. The headache was less severe and there was no aural discharge. The following day, *September 20th*, his condition suddenly changed. At 21.00 hours his temperature had risen to  $101.2^{\circ}$  F. and his pulse, which had previously averaged 82 per minute, had fallen to 64 per minute. He was drowsy and unco-operative and complained of severe generalized headache, throbbing in character and experienced most severely in the left temporal region. Otoscopic examination revealed a fairly brisk watery discharge coming through the perforation of the left tympanic membrane. He was not sweating. His pupils were equal in size and shape and reactive to light and accommodation in a normal fashion. There was definite neck rigidity and a positive Kernig's sign was elicited. The abdominal reflexes were present on the right side but absent on the left. The ankle tendon reflexes were both present while the patella reflexes were exaggerated. In the arms the tendon reflexes were bilaterally diminished. No other abnormal neurological signs were detected and no abnormal physical signs were discovered in

## Clinical Records

the chest and abdomen. A lumbar puncture was performed at 22.00 hours when 15 c.c. turbid fluid were withdrawn under pressure. Unfortunately no manometer was available. The laboratory report was as follows :

Total cell count	..	..	..	..	467.5 per c.mm.
Leucocytes	..	..	..	..	III
Erythrocytes	..	..	..	..	356.5
Culture	..	..	..	..	Sterile

A prophylactic course of sulphathiazole was begun.

On *September 21st* his morning pyrexia was only 99° F. He felt better and was more co-operative, but his headache was still severe. On *September 22nd* his condition had improved considerably and he was a pyrexial. Some abnormal neurological signs persisted. All the tendon reflexes were present and brisk. Both plantar responses were extensor and only the right upper abdominal reflex was present. A horizontal nystagmus was manifest when he looked to the right and some degree of cerebellar disturbance was shown by the inco-ordination of the voluntary movements of his left arm. An ophthalmologist reported no abnormality of the fundi.

On the same day lumbar puncture was repeated. The pressure of the cerebrospinal fluid was diminished clinically by comparison with the previous occasion. The laboratory reported :

Total cell count	..	..	..	..	66 per c.mm.
Leucocytes	..	..	..	..	53.5
Erythrocytes	..	..	..	..	12.5
Culture remained sterile.					

Routine hearing tests of the left ear with the standard tuning fork (C1256) gave a negative Rinne and a marked diminution of absolute bone conduction (—20 seconds). The following day, *September 23rd*, his headache was less although the nystagmus persisted. All abdominal reflexes were present but the plantar responses were indefinite. On *September 24th* he was more cheerful, his headache had disappeared and he washed himself. The plantar responses were still indefinite but by *September 25th* they had both become flexor. Apart from the persistence of a suggestion of horizontal nystagmus, the abnormal neurological signs were no longer in evidence. Otoscopy showed the perforation of the left tympanic membrane still present with a slight watery discharge.

The total amount of sulphathiazole exhibited was 35 gm.; 12.5 gm. of sulphanilamide had been given before the patient was admitted to the Casualty Clearing Station.

He was then evacuated as a lying case to a Base Hospital.

I subsequently received a letter from this patient dated *November 4th*. He was still in hospital and stated that his left ear was giving him some trouble and that he could not hear with it at all well. The spoken voice in that ear as "a jumble of words". Otherwise, apart from an occasional headache, he had no complaints.

The otologist who took over the case also kindly communicated with me. The patient's condition on *November 9th* was as follows : ..

Slight nystagmus persisted both to the left and to the right. The left ear was dry. Air conduction was absent and the conversational voice, but not a

## J. A. Seymour-Jones

whisper could be heard in both ears at 12 feet. He was discharged from hospital to a convalescent depot after his medical category had been temporarily lowered by a Medical Board to B.6.

### Summary

A case is described of blast injury to the ear producing a rupture of the tympanic membrane and derangement of the inner ear. Symptoms which appeared initially to be functional were later shown to be organic in origin and signs of meningeal irritation occurred owing to leakage of blood into the cerebrospinal fluid. It is thought that the scanty otorrhœa may have been in fact a leakage of cerebrospinal fluid, but at no time was it profuse. Recovery, though incomplete, was not unsatisfactory.

## SOCIETIES' PROCEEDINGS

ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

March 3rd, 1944

*President*—T B JOHNSON, M D

### Surgical Treatment of Otosclerosis

I SIMSON HALL, F R C S E

THAT hearing can be improved by making an artificial opening into the labyrinth has been known since 1876, when Kessel first demonstrated the fact

The main object of the surgeon since that time has been to replace the immobilized stapes by a movable membrane. Whether this is justified as the main aim is still open to proof, but the fact remains that mobilizing the fluid within the labyrinth results in an immediate and most dramatic improvement in hearing.

This may be accomplished in a variety of ways. It may be carried out with a small sized mastoid gouge, used as a scraper, and a small hand lens, giving almost negligible magnification, or it may be carried out with elaborate equipment which is commonly used now. It is interesting to recall that one of my most successful fenestrations was done with the aid of the simpler equipment.

The technique for my earliest operations was very similar to that which I employ to day, but without the specialized equipment. It is significant that improvement in results has kept pace with advance in technique.

Following Sourdille's advice I tried doing the operation in multiple stages, and experimented with cases using one to three stages. I came to the conclusion that there was no advantage in my hands of prolonging treatment, and I settled down to carry out the operation in one stage.

The position of the fenestra has also been the subject of some experiment. It has been placed in the canal itself following Holmgren's ideas. The same position was tried using Sourdille's technique. Then for a series of cases, a position over the ampulla was used. Again a reversion to the original technique was made, placing the fenestra over the ampulla, and that is the method used in the latest series.

A series of cases was also operated upon using the roof of the vestibule as advocated by Lempert, but, possibly by chance, this series was found to give inferior results, and the opening was taken more posteriorly to its former position. Perseverance with Lempert's position of the opening might have been found to give results similar to that obtained in the other methods, but the method used now is the easiest technique of all.

Approach to the middle ear is made through a post aural incision or an end aural incision. It does not matter which route is used provided that the

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operator is familiar with the method. I used the end-aural route in mastoid operations a sufficient number of times to make my operating time the same as when using the post-auricular route, which I take to mean that facility with either route was equal. Having reached this point, I decided that the post-auricular route was superior.

## ANÆSTHESIA

The ideal anæsthetic for this operation is one which gives a slight degree of anæsthesia, lowers the blood-pressure, and is safe to use over a prolonged period. This anæsthetic has, unfortunately, not yet made its appearance. Local anæsthesia permits testing of the hearing on the operating table and gives a bloodless field. Pre-medication, with hyoscine and omnopon, is of great assistance, and I have tried avertin and other basal narcotics. A method I found very effective was to use local anæsthesia up to the opening of the labyrinth and when the patient became distressed, as is usual at this point, to give pentothal intravenously for as long as necessary.

At present a heavy pre-medication followed by light ether is the method used, and this is satisfactory on the whole as I have found that the delay caused by bleeding is more than compensated by the immobility of the patient and the greater speed which can be achieved under general anæsthesia. The small movements of the patient which occasionally take place under local anæsthesia are annoying when using the microscope, and general anæsthesia eliminates these.

## THE OPERATION

The duration of the operation as a rule is about two hours, with about an hour and forty-five to fifty minutes' operating time.

The operation very closely follows the lines of the modified radical mastoid operation in the exposure of the labyrinth, with one or two slight modifications.

One of the most important parts of the first half of the operation is the formation of what is sometimes called the "meatal plastic". This is the mobilization of the postero-superior portion of the lining of the external auditory meatus and the membrana flaccida in a continuous flap, which is used to cover the new opening in the vestibule. This is a critical point of the one-stage operation as, should the flap be torn, the operation may have to be abandoned, or concluded as a two-stage operation.

Bleeding during the raising of the flap is apt to be troublesome but the preliminary infiltration of the area with normal saline and adrenalin solution helps considerably.

With the formation of the flap the usual plastic procedure for enlarging the external meatus is carried out according to the custom of the operator.

When the small flap is laid back the contents of the middle ear are open to inspection. The capsule enclosing the heads of the incus and malleus is incised with a fine-bladed knife; this frees the incus which can be removed without fear of damage to other structures.

The head of the malleus is then separated from the rest of the bone by division at the neck with a fine-pointed pair of scissors. This completes the

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first stage of the operation and the exposure of the horizontal canal and the roof of the vestibule

For the second stage a microscope or other magnifying device is required, together with the drill, and the irrigating and suction apparatus

The arranging of the apparatus makes a definite break in the operation, and advantage is taken of this by the surgeon and his assistant to change gown, gloves, etc. Fresh towels are spread and the trephining of the labyrinth is commenced

Each operator will have his own preference for a particular type of drill, but many types are available, from the coarse cutting drill for the early stages, to the fine polishing stone for finishing the cavity. In the beginning any rough corners or pieces of bone are quickly smoothed off with a fast cutting burr and the superficial layers of the vestibular roof are removed till the bluish cavity shows through

When it is evident that the bony roof is becoming thin, the depression in the roof of the vestibule is carefully shaped and then polished. The edges of the bone covering the endosteum are then thinned with a fine burr till the endosteum is reached and the remaining bone and endosteum can frequently be removed with an elevator almost in one piece. The ampulla and canal can be identified immediately and the remaining shreds of endosteum and small pieces of bone are removed with scrapers, and other instruments specially made for the purpose. It is for this work that adequate magnification is absolutely essential. This completes the opening of the labyrinth. All that remains to be done is to spread the small flap over the fenestra and secure it in position with paraffin packs. The wound is closed completely

## POST OPERATIVE TREATMENT

As a rule the wound is left undisturbed for one week when the pack is removed, the stitches are cut, and daily packing with paraffin gauze is resorted to. In the majority of cases a skin graft is inserted about the tenth day. A point which should be emphasized with regard to the after treatment is that asepsis is essential. It is my experience that nothing leads so quickly to deterioration of hearing as infection of the cavity

The duration of stay in hospital varies according to the patient's ability to attend for dressing. In the case of a patient living near the stay in hospital is about two weeks

Following operation there is evidence of labyrinthine disturbance, nystagmus to the opposite side, giddiness and past pointing error. This lasts to a degree of discomfort for about four days after which it is noticeable to the patient only on movement. It may persist for three weeks or even longer and is noticeably slower to settle down in older people than in young

The condition of the hearing immediately subsequent to operation is quite a good index to success and I await with interest the report of the nursing staff. When they tell me that the patient is complaining about the noise in the ward on the morning after operation I anticipate a successful result although the hearing may shortly afterwards become poor, but when the patient shows apathy and lack of interest I suffer a corresponding disappointment. A small



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number of patients do not show the usual post-operative drop in hearing acuity and these, as a rule, are the most successful cases.

On the average about three to four weeks elapse before there is any noticeable improvement and the highest level is reached immediately after the ear cavity is healed, usually in eight to ten weeks. This may amount to thirty decibels, but the average is about twenty-five decibels. Hearing tends to decrease after about two years till a permanent level of fifteen to twenty decibels gain is reached.

### RESULTS OF OPERATION

In all, sixty-six operations have been carried out during the last six years. As technique has varied so greatly and so many methods have been tried it is impossible to assess the value of the operation by quoting tables of figures.

It is found in analysing results that improvement, if maintained for more than four months after operation, is likely to persist for some time, therefore cases operated upon within the last four months must be disregarded. Also, it is of no value to compare the earliest cases, operated upon with an equipment consisting of a hand lens and a scraper, with those operated upon with up-to-date methods, so that a number of the earliest cases must be excluded from analysis.

When this has been done we are left with a total of forty-five operations available for examination. Of these six have been lost sight of, and of the remaining number 20, or 51%, show improvement to-day.

These figures are of little practical value as they indicate the results of an operation which has differed from time to time in many particulars, and has been carried out on many types of case, suitable and unsuitable, and of varying ages.

One of the most frequent questions asked is whether the improvement which is gained will last. It is found that of cases operated upon prior to 1940, 36% have retained their improvement in hearing. In the period of twelve months, eighteen months ago to six months ago, the percentage improvement is 66%.

This affords a much fairer picture of the prospects of operation for, as might be expected, the most recently performed show the highest percentage of success. It is unlikely, however, that this comparative improvement is entirely due to the more recent date of the operations, for year by year the immediate failures are approximately equal, and the number showing late deterioration is fairly constant. The probability is that the latest group will show a higher percentage of final improvement.

In seeking an explanation of this several possibilities appear. The technique may have altered radically, the operator may have gained in skill, or the selection of patients may have been carried out in a more critical manner.

We may assume that technical efficiency has increased but this would account only for a very small part of the gain. Method, no doubt, is much more important and we find that removal of the incus gives an improvement rate of 54% as against 31% when it is retained. This may be interpreted in different ways. There is obviously no difference in the immediate results, and we must look for an explanation to some influence upon the remote effect.

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I feel the most probable explanation of this is that the retention of the incus causes the fenestration to be carried out on the average more posteriorly on the canal, while removal facilitates the fenestration over the ampulla and the roof of the vestibule. A larger opening can be made there with much greater accuracy.

## COMPLICATIONS

There has been one death in this series. This patient was a man aged 38, who died about six hours after operation, following an injection of a quarter of a grain of morphia which was given as routine to ensure rest after recovery from the anæsthetic.

Subsequent inquiry was strongly suggestive of an idiosyncrasy to morphia as he had nearly died some years previously, following an operation under local anæsthesia.

Apart from this case no patient has left hospital with other than a functioning labyrinth, showing that with proper precautions this operation can be undertaken without danger to life except such dangers as are inseparable from any major operation.

Cross infections are not uncommon in a crowded nose, throat and ear department and as long as accommodation for segregation of these patients is not available, they will continue to give anxiety. Of such infections those leading to acute otitis media give the most anxiety and there have been three cases of this. Happily no serious harm resulted and the patients recovered without further trouble. In one case a particularly good result was obtained, in the others, the hearing was the same as before operation.

Cavity infections are a particularly unfortunate complication and unless checked at once are almost certain to ruin any chance of improvement in hearing. There have been no cases of facial paralysis, and no cases of labyrinthitis.

## OTHER EFFECTS OF OPERATION

Confusion of sounds is the rule after operation, and it is not easy for a patient at first to pick out the voices from the mass of amplified noise which surrounds him, and I have found that some did not try and so failed to make use of an obvious increase in acuity.

An interesting phenomenon has been observed in connexion with this confusion which is based on the failure to orientate sounds. This is illustrated by the statement of a patient that she frequently found that she looked to her left when someone spoke on her right. The same condition was evident in a patient who said she felt that the tramway cars were chasing her on to the pavement apparently she saw the car approaching but the sound seemed to be behind her on the pavement. This is probably explainable on a purely physical basis, but it opens up some interesting questions for investigation.

Another circumstance which is of interest is the influence of pregnancy upon the regained hearing. Two patients have become pregnant subsequent to operation. In one case hearing deteriorated to some extent, in the other hearing remained stationary.

The question may be asked whether the operation, when successful, unfits the patients in other ways for employment. In the majority of instances the

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patients are sedentary or office workers, and physical effort plays a small part in the earning of a livelihood. There have been instances where the operation has had some effect on capacity for work. This was illustrated recently by the experience of one young man, a riveter by trade, who had a slight sensation of giddiness on stooping suddenly, and when riveting inside a ship's boiler he found the reverberation too much for him and had to be shifted to an outside job. This disability, however, did not lessen his usefulness as a worker.

### SELECTION OF PATIENTS

Selection of cases has a great deal to do with results. In the earlier series almost any type of patient suffering from middle-ear deafness was accepted provided they showed no signs of middle-ear disease—cases of mixed middle- and inner-ear deafness were purposely selected to ascertain whether the improvement of the middle-ear component of the deafness would result in useful hearing. We know from that experience that such patients derive no permanent benefit and so they are now refused. Sinusitis and nasopharyngeal infections are contra-indications to operation.

There are certain common characteristics in those showing improvement. The majority are young—usually under thirty years—the deafness is not extreme, there is neither sign nor history of middle-ear disease, and there is no nerve deafness. A family history of deafness is regarded as confirming the diagnosis and favouring a successful result, and finally the patient must be intelligent. This is necessary so that the patient may re-educate himself to use the regained hearing.

Many patients have been under observation for a period of years. Repeated audiometer records are made, and operation is undertaken only when there is strong evidence of steady deterioration of hearing.

Routine tuning fork tests are done but the audiometer record is the chief guide though, of itself, it is not always reliable in nerve deafness. *Not having* two similar audiometers for tests, I rely for confirmation on the monochord. Lack of appreciation of the upper tones by bone conduction has proved a contra-indication to operation, and where this is discovered, I always now refuse the patient for operation.

Some failures may be attributed to age; also infection of the cavity either during the convalescent period or later, owing to accumulation of wax or other causes, always means loss of hearing. Technical failure plays its part though I have notes of only one case where a complete breakdown in the electrical system contributed to failure. In another case obvious signs of previous labyrinthitis were found at operation.

### CLOSURE OF FENESTRA

It seems that patency of the fenestra is of the utmost importance in retention of improvement in hearing. In many of these cases listed as failures, a fistula sign can be elicited but one can readily recognize the loss of sensitivity which presages failure.

There is a tendency in some cases for the hearing to remain stationary while that of the other ear continues to deteriorate. This can be shown clearly by audiogram.

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It seems that now we have reached the stage when technical advancement has almost ceased and the future of this operation rests upon the results of research into the question of bone regeneration

(The paper was illustrated with lantern slides showing the various stages of the operation apparatus, and audiometer records of various types of cases)

MR TERENCE CAWTHORNE I am most interested in the technique of and the effects produced by opening the perilymph space of the external semi-circular canal and it is about this particular procedure that I should like to give you my experiences

It will be convenient to consider the surgical treatment of otosclerosis in three stages

(1) *The surgery of access*—It has been clearly shown by Sourdille, Lempert and others that the open operation offers a greater prospect of success than the closed, without any undue risk of infection spreading inwards. In the four cases in which I have opened the perilymph and endolymph spaces through a dry radical mastoid cavity for intractable vertigo, recovery has been uneventful

So far, I have only made use of the closed method of access and in the first four cases of otosclerosis on which I operated, this stage was carried out under general anaesthesia, the opening of the perilymph space being carried out under local anaesthesia after an interval of one or more weeks. The meatal approach as advocated by Lempert offers certain advantages which in accustomed hands probably outweigh the difficulties of working in a restricted field

Whatever method of approach is used it is, of course, essential to achieve complete haemostasis before the second stage is embarked upon. It was because of the difficulty of checking oozing that I abandoned the two stage operation though it is possible that there would have been less trouble in this direction had I allowed a greater interval to elapse between the two stages

(2) *Opening the perilymph space*—This stage is also part of the operation that Hallpike and I described at this Section last year for the relief of Meniere's disease (*Proceedings*, 1943 36, 543)

In the first place this stage demands a certain degree of magnification if it is to be carried out accurately, safely and with ease

Once one has become accustomed to it, the advantages of working in a magnified field, such as is provided by a binocular dissecting microscope giving ten diameters of magnification, are sufficient to warrant urging its use for this stage of the operation

I have found that a portable dental machine driving a diamond paste burr at 3,000 r.p.m. a convenient and very safe way of making the window in the bony external canal. It is advisable to make the opening in the anterior and inferior aspect of the convexity of the bony canal because in this way there is less chance of damaging the membranous canal which is usually in contact with the inner wall of the bony canal in the upper part of the convexity. At this stage I usually remove the incus which otherwise is liable to be damaged by the drill and this allows a much greater freedom of manoeuvre

The dry, powdery bone dust that is thrown off by the drill can at this stage be easily removed by following the drill in its excursion with a fine suction tip. This enables the fundus of the trough so formed to be clearly seen the whole time, and the dark line marking the approach to the perilymph space may be

recognized in good time. This is the time to make sure that all the bone dust is removed for once the perilymph oozes out, it is not at all easy to remove all traces of sodden bone dust.

As the innermost layer of bone is gently thinned down, perilymph slowly oozes through one or more very tiny holes, although the main mass of bone is apparently intact. In the conscious patient I have noticed that at this stage vertigo is complained of and may be sufficient to cause some distress. There is not, however, any noticeable improvement in the hearing. Very soon the thin irregular lamina of bone breaks away and it is at this moment that a dramatic improvement in the hearing takes place. This thin flake of bone, that may be likened to a flake of what we call a "cream cracker biscuit", often breaks into several pieces, the removal of which by means of fine dental probes may be troublesome and tedious. Any attempt to remove excess perilymph by suction or worse still by cotton mops, is very liable to drain it away, leaving the perilymph space of the canal temporarily dry. This will, of course, increase the difficulty of removing any retained bone dust or chips.

Also, the displacement and apparent collapse of the membranous canal cannot, I feel, be a good thing. I have not been able to record any constant variation between the amount of perilymph exuded in cases of Ménière's disease or otosclerosis or indeed in the amount seen in any two cases of the same disease. If by chance it has been drained away, it usually seems to re-form within a few minutes and it seems to re-form more quickly if there is any venous obstruction. Once the initial outflow has taken place it does not, as a rule, flow over again, at any rate within the half-hour or so that I have watched these cases. Nor have I ever seen anything to suggest any escape of perilymph after the operation. This is, I think, because a film of fibrin seals over the opening fairly quickly.

With regard to the possible danger of blood entering the perilymph space and jeopardizing the result, I do not think that this can happen easily if there is a good head of pressure of perilymph, though I do not think because of this precautions against bleeding should in any way be relaxed.

The membranous canal is surprisingly tough and will stand quite a lot of handling without breaking. This is a source of great comfort, though I would not like to say what indirect effects might follow unnecessary trauma, and I feel sure that in operations for otosclerosis the membranous tube should, if possible, not even be touched.

(3) *The protection and maintenance of the opening.*—So far this has proved to be the most difficult obstacle to overcome and I fear that I have no useful contribution to offer to the discussion. Lempert, Canfield, Campbell and Shambaugh, to mention a few, have made special studies of the factors that influence the closure of the window by new bone or fibrous tissue formation, and it is considered that such closure is responsible for the failure to maintain the initial improvement in hearing. So far I have only used the closed method employing flaps of muco-periosteum and fibrin to cover the window, but it would seem that the best results follow an open operation where flaps of tympanic membrane are laid against the window. The transient reaction that follows does not appear to have an unfavourable influence on the final result. I notice that Campbell advocates thinning down of the bony canal without actually

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opening the perilymph space and it would be very interesting to hear from other speakers if they have any experience of this procedure

*Results*—My results so far have been uniformly disappointing. In the eight cases upon which I have operated all experienced an immediate, and in some instances remarkable, improvement in hearing but without exception the hearing gradually deteriorated to the pre-operative level within a month. In no case has it become appreciably worse within the period that they have been under observation. In every case the post-operative vertigo and nausea, though of short duration, have been more severe than after labyrinthectomy for Ménière's disease. This is not surprising as presumably the otosclerotic has an active labyrinth, whilst the vestibular function in those cases of Ménière's disease submitted to operation is always diminished.

This post-operative reaction cannot be explained entirely on the grounds of a serous reaction because it appears as soon as the perilymph space is opened and is at its worst directly after the operation.

There are several aspects of the fenestration operation for otosclerosis that require further investigation and perhaps the most important is why does the hearing improve when the perilymph space is opened? Is it because sound waves are transmitted through the opening to the basilar membrane and if this is so, by what route do they travel? And why do we not hear of more cases in which loud sounds cause vertigo?

There was one case of Ménière's disease in which the perilymph space was opened without interfering with the membranous canal. Subsequently it was found that the patient gave a very noticeable vestibular reaction to loud sounds. This was so troublesome that within a month it was necessary to remove the membranous canal.

MAJOR E. P. FOWLER, JR., U.S.A.M.C. Perhaps if the causes of bony closure in monkeys were examined, they would help in humans. The most potent cause of closure is undoubtedly bone dust and bone chips. Infection in the flap or in the labyrinth also produces closure. There was some question whether premedication with sulphonamides or penicillin might not help in this connexion. The position of the fistula theoretically also would affect closure. If the fistula were made where there was much endochondral bone and little periosteal bone the fistula would not close, for endochondral bone does not grow as does periosteal bone. The periosteal bone should be removed carefully for it is potentially a rapid bone former. Epithelium apparently inhibited bone growth in some monkeys. The fistula should be made with a burr and the edges highly polished. Colonel Canfield has done experiments showing the bone growth is inhibited by the use of a polishing burr.

As to the position of the fistula on the semicircular canal itself, Major Fowler said the thinnest bone was over the white bright smooth area which is often considered to be the ampulla. Actually the membranous ampulla was much further forward than one would think. It is over this that Lempert makes his fenestra novae ovalis. Lempert had described something called the 'dome' of the vestibule which is an unfortunate term. If one really went through the top of the vestibule, one would have to cut through a great deal of bone and through the nerves of the labyrinth, which was technically difficult in the living subject.

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There was one other thing which might cause closure of fistula. One of his early cases had a very severe otosclerosis, and when she was reopened it was found that the first fistula had closed, and there was a most extraordinary coloured bone over the whole canal; it looked yellow instead of the usual ivory colour. The endochondral capsule was invaded by otosclerosis to the area ordinarily used for these fistulas. When extensive otosclerosis is suspected the operation should not be performed in old people nor in very deaf people.

With regard to dizziness from loud sounds he thought the American underground railway was louder than the British for all his patients had complained of dizziness when travelling on the underground railway.

He had experimented with microscopes for a long time and finally found that a pair of binoculars such as used by mineralogists proved most useful. It gave him 26 cm. to work in and to shine the light through and could be easily surrounded by a sterile shield. He used 7 to 10 magnifications.

SURGEON-COMMANDER E. R. GARNETT PASSE (*in absentia*): One of the most important problems still to be solved in otosclerosis is that of diagnosis; and to add further to the confusion we now have blast deafness, of which I have seen many cases of late. The audiometer chart alone does not differ in many ways from that of the early perceptive deafness and we will have to be on the lookout for these cases before making a diagnosis of otosclerosis. The history alone of blast or gunfire injury is not in itself sufficient. In *September 1939* (*J. Laryng. and Otol.*, liv, 566), I recorded the results of surgical treatment of 14 cases of otosclerosis performed during the preceding eighteen months, using both Holmgren's and Lempert's techniques. However, only one of these cases now shows any improvement. Since then I have used Lempert's vestibular dome as the site of fenestration and I am hopeful that the immediate good results will prove more lasting. To my mind it does not matter where the site of fenestration is so long as the perilymph is decompressed and the opening made permanent, or at least permanently membranous. Contrary to Nasiell's article I am further able to support Meyer's work on decompression of the C.S.F., for during the last two years I have had temporary improvement in hearing on removal of large quantities of C.S.F. and replacement by air, with the effect that several officers and men in the Royal Navy have been able to continue with their work and they willingly submit to the decompression from time to time.

To my mind the essential underlying cause of otosclerosis is a vasomotor disturbance, as described by Wittmaack. According to the theory of Leriche and Policard, in order for calcification to occur there must be present three factors—an ossifiable medium, a rich source of calcium locally and a poor blood supply. The blood supply to the bony parts chiefly affected in otosclerosis is derived from branches from both the internal auditory and the internal carotid arteries. The neurovascular supply of these arteries is *via* the plexus surrounding the vertebral and internal carotid arteries and there is some belief that the vasoconstrictor fibres are passed by the 1st and 2nd divisions of the Vth cranial nerve. This opens up further possibilities in the surgical treatment of otosclerosis for it is possible that there may exist an anatomical abnormality in the course of this nerve supply which interferes with its normal function, and I think the future treatment of otosclerosis lies not in the organ itself but at some faulty part of its peripheral control.

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MR WALTER HOWARTH said that he was very interested in the end-results of these cases because he thought that as the years passed they were apt to deteriorate. His experience of this operation of labyrinthine fenestration amounted to seven cases which he did in 1937 following out Holmgren's technique, but the results were very disappointing. They were carried out under local anaesthesia and all got the immediate dramatic improvement in hearing, but of the seven cases within six weeks five had gone back to the pre-operative degree of hearing. Unfortunately the war had prevented a proper follow-up but he saw one case last year quite by accident, when the lady was sent to him by a gynaecologist to ask if it was safe for her to have a baby, and he found the hearing had remained with a considerable degree of improvement over the five year period.

MR C A HUTCHINSON said that a point apt to be overlooked was that in otosclerosis one was dealing with a general systemic disease and not merely with a local condition. Certainly the most interesting and probably the most correct of the many theories as to its aetiology was that put forward by Eckhart Moebius accordingly surgery combined with appropriate general treatment offered a better chance of success than pure surgery alone.

In May 1939, he had shown one case in the section which after the lapse of nearly five years still retained a very considerable portion of the primary improvement secured.

He was particularly interested in the fact that the many and varied initial techniques had become more or less standardized, all workers stressed the importance of the removal of bone chips, all used practically identical instruments, and all opened the labyrinth in almost identically the same position.

Like Mr Simson Hall, he employed a continuous but controllable saline stream to remove bone chips, but added a few drops of adrenalin to help control haemorrhage.

With regard to anaesthesia he had found gas oxygen trilene combined with omnopon-scopolamine premedication produced least haemorrhage during and after operation.

He envied Mr Simson Hall his operating microscope. Unfortunately his own work had been interfered with by three years war service, he had tried on his return to obtain a similar instrument, but had failed and was therefore grateful to Major Fowler for his suggestion of an alternative such as mineralogist's binoculars. He had been using a Harman loupe, but its grave disadvantage was its short focal length causing insufficient room for instrumentation and difficulty in securing adequate illumination of the field of operation.

MR SIMSON HALL (in reply) said that in his opinion irrigation under complete control, and either constant or intermittent as required, formed the solution to many difficulties such as bleeding and troublesome bone dust. Adequate magnification was also of very great importance, in his opinion about 10 diameters was the optimum. This could be increased, however, in special circumstances, e.g. by eyepiecing. The working distance was of importance and his instrument allowed about 15 cm. but what was of equal importance was the access which the instrument provided. Some dissecting microscopes were very bulky.



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Selection of patients was still one of the most difficult points. He agreed that extreme deafness was a contra-indication to operation. An attempt had been made to investigate patients as completely as possible, particularly in conjunction with an endocrinologist. Results so far were inconclusive.

Deterioration of hearing following operation had to be judged not only by the decibel loss from the original post-operative gain, but in relation to the probable position of the hearing had no operation been performed. That is to say, although the average immediate gain of 25-30 decibels was found as a rule, to have sunk to a permanent level of 10-15 decibels after two or more years, the real gain to the patient was this 10-15 decibels plus the amount of deterioration in the opposite ear. That figure represented the real gain to the patient from the operation.

The patients experience a sense of relief and new hope in their lives which was reflected in their appearance and outlook.

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## AN INVESTIGATION INTO THE INCIDENCE OF ACUTE OTITIC BAROTRAUMA AS A DISABILITY AMONGST 1,000 AIRCREW CADETS DURING A DECOMPRESSION TEST

By Air Commodore E D D DICKSON, Squadron Leader J E G McGIBBON,  
Squadron Leader W HARVEY Squadron Leader W TURNER,  
(from the Ear, Nose and Throat Department, Central Medical Establishment,  
Royal Air Force)

### *Definition of Acute Otitic Barotrauma*

Acute otitic barotrauma, which results from differences between the atmospheric and intratympanic pressures whilst flying or during decompression and recompression in a chamber, is due to inadequate ventilation of the middle-ear cleft through the eustachian tube. It has been known variously as "aero-otitis media", "eustachian-block", "eustachian obstruction" and "aviation pressure deafness". The syndrome occurs most frequently during descent in aircraft and compression in a chamber.

All degrees of barotraumatic change and severity of symptoms may be produced by pressure variation in the middle ear. In many cases there is a symptomless congestion of the drumhead, in others the congestion of the drumhead is accompanied by mild symptoms which are relieved at once by auto-inflation, and lastly there are cases with signs and symptoms of varying severity which are unrelieved by attempted auto-inflation. The two former mild types of barotraumatic change do not give rise to any disability and it is to the last-mentioned disabling types only that the term "acute otitic barotrauma" is applied in this report.

Subjects suffering from acute otitic barotrauma complain of pain and/or deafness and on examination their drumheads are seen to be congested, invaginated and occasionally hæmorrhagic. These changes

are sometimes accompanied by a frothy, serous or sanguineous effusion into the middle-ear cavity, and in severe cases rupture of the tympanic membrane may be present.

The condition constitutes a definite disability amongst aircrew personnel and any means of predicting its occurrence would be a valuable prophylactic measure in aviation medicine.

## *Objects of the present investigation*

The present investigation was undertaken to ascertain :

- (1) The incidence of acute otitic barotrauma as a disability amongst 1,000 aircrew cadets during the decompression test to be described later.
- (2) The effect of previous flying experience upon the incidence of acute otitic barotrauma in 1,000 aircrew cadets.
- (3) The effect of any of the following conditions as contributory factors to the development of acute otitic barotrauma in 1,000 aircrew cadets.
  - (a) *History of any previous aural and/or upper respiratory complaints and/or operations.*
    1. Acute otitis media.
    2. Aural discharge.
    3. Earache.
    4. Deafness.
    5. Aural operations.
    6. Frequent colds.
    7. Nasal "catarrh".
    8. Nasal obstruction.
    9. Nasal operations.
    10. Frequent sore throats.
    11. Removal of tonsils and/or adenoids.
  - (b) *Complaint of present "cold" and positive clinical findings of acute nasopharyngitis.*
  - (c) *Other abnormal clinical findings in the upper respiratory tracts :*
    1. Presence of abnormal tympanic membranes.
    2. Objective non-patency of the eustachian tubes.
    3. Unhealthy and/or hypertrophic tonsils and/or adenoids.
    4. Post-nasal scarring.
    5. Mucus and/or mucopus in the nasal fossæ and/or post-nasal spaces.
    6. Included in (b) above.
    7. Obstructive deviations of the nasal septum.
    8. Dullness of the maxillary antra on transillumination.
  - (d) *Malocclusion of the teeth.*
- (4) The incidence of sinus barotrauma.
- (5) The incidence of dental barotrauma.

# The Incidence of Acute Otitic Barotrauma

The following subsidiary investigations have arisen out of the main enquiry

- (6) The incidence of barotraumatic changes in general (disabling and non-disabling) as a pathological entity, in the middle ear clefts of 1,000 aircrew cadets during the decompression test
- (7) The comparative values of the objective methods of recognition of patency of the eustachian tube
- (8) The minimal nasopharyngeal pressures required to cause air entry into the middle ears of 1,000 aircrew cadets as judged by visible movement of the drumhead
- (9) The "practice-effect" on the performance of Valsalva's manœuvre

## *Description of the investigation*

Every cadet was subjected to a thorough clinical examination of the nose, throat and ears and a history of any past upper respiratory complaints and operations was obtained. Before admission to the decompression test the principles involved in atmospheric pressure changes as they affect the middle ear cleft during flight were explained, and the cadets were instructed in the correct methods of ventilating their middle ears by swallowing, by Valsalva's manœuvre and by movements of the lower jaw. To accustom the subjects to the effects of pressure variations a trial run was made before the actual test by decompression to a pressure corresponding to an altitude of 4,000 ft and recompression to ground level pressure at 2,000 ft/min. This was followed by the test proper which consisted of decompression to a pressure corresponding to an altitude of 10,000 ft at 3,000 ft/min, and after a pause of 5 minutes at this pressure, recompression to ground level pressure at 3,000 ft/min, increasing to 4,000 ft/min. Contact with the subjects was kept by an intercommunication system and the pressure and its corresponding height at which any symptoms occurred were noted. Immediately on reaching ground level pressure an otoscopic examination was carried out to ascertain the appearances of the tympanic membranes. Subjects who complained of symptoms which were unrelieved by attempted auto-inflation and who showed tympanic changes were considered to have failed in that particular test and they were subjected to further decompression tests at intervals of from 7 to 10 days. The results of the test were classified as follows

- (a) Tested once and passed with unaffected tympanic membranes
- (b) Tested once and passed with congested tympanic membranes but with no symptoms
- (c) Tested once and passed with congested tympanic membranes and slight symptoms which were relieved at once by Valsalva's manœuvre
- (d) Tested twice, having failed the first test (a, b and c) and passed the second

(e) Tested three times, having failed twice and passed the third time.

(f) Tested three times and failed in all three tests.

It was assumed that some persistent contributory factor to the production of acute otitic barotrauma was present in the subjects who failed on all three occasions (f).

Audiometric tests were carried out on the first 250 subjects and repeated on those who complained of symptoms on completion of the test. Since the conditions of background noise were very variable this procedure was abandoned as the results were not considered to be reliable.

A copy of the form used in the investigation is attached (see Appendix I).

### *Results of the investigation.*

The incidence of acute barotrauma of the ears, sinuses and teeth as a disability is shown in Table 1.

TABLE 1

*The incidence of acute barotrauma of the ears, sinuses and teeth as a disability*

Acute otitic barotrauma ..	86	} Total acute otitic barotrauma	89 (8.9%)
Acute otitic with sinus barotrauma ..	2		
Acute otitic with dental barotrauma ..	1		
Sinus barotrauma .. ..	15	} Total sinus barotrauma	18 (1.8%)
Sinus with acute otitic barotrauma ..	2		
Sinus with dental barotrauma ..	1		
Dental barotrauma .. ..	11	} Total dental barotrauma	13 (1.3%)
Dental with acute otitic barotrauma ..	1		
Dental with sinus barotrauma ..	1		
Total cases .. ..	116 (11.6%)	Total incidence	120 (12.0%)

The incidence of acute otitic barotrauma in 1,000 cadets who were tested as described earlier is shown in Table 2.

TABLE 2

*The incidence of acute otitic barotrauma as a disability in 1,000 aircrew cadets during the decompression tests*

(a) Tested once and passed with normal drumheads	586 (58.6%)	} <i>No disability</i> —911 (91.1%)
(b) Tested once and passed with injected drumheads but no symptoms .. ..	277 (27.7%)	
(c) Tested once and passed with injected drumheads and mild symptoms relieved at once by auto-inflation .. ..	48 (4.8%)	
(d) Tested twice, having failed first test, and passed second test .. ..	70	} <i>Acute otitic barotrauma</i> —89 (8.9%)
(e) Tested three times, having failed twice, and passed third test .. ..	12	
(f) Tested three times and failed in all three tests ..	7	

1 cadet complained of toothache which he referred to the ear on the affected side; and 1 cadet who developed an effusion in his middle ear would admit to no symptoms in spite of strict questioning.

59 patients complained of earache (49 unilateral and 10 bilateral) which cleared at once on Valsalva's manœuvre. 48 of these showed

# The Incidence of Acute Otitic Barotrauma

injection of one or both drumheads (39 unilateral and 9 bilateral) after leaving the chamber, and these are included in Table 4B. 11 had no abnormal otoscopic signs on leaving the chamber and they are included in Table 4A.

586 (58.6 per cent.) subjects, including the 11 mentioned above, shown under Table 4A, were objectively unaffected by the test. 414 (41.4 per cent.) cadets developed a varying degree of vascular engorgement of their drumheads with or without symptoms, Table 4B and C. 89 (8.9 per cent.) of the subjects (Table 2, *d*, *e* and *f*) manifested objective changes and subjective symptoms of such a degree as to constitute a disability and they have been classified as suffering from acute otitic barotrauma. (A more complete analysis of these 89 cases of acute otitic barotrauma is given later). The remaining 325 (32.5 per cent.) subjects (Table 2, *b* and *c*) suffered no disability owing to the absence or transience of any symptoms. These cases are discussed later in Section 6.

## (2) *The incidence of acute otitic barotrauma as a disability in relationship to previous flying experience.*

409 of the cadets had previous flying experience varying from  $\frac{1}{2}$  to 200 flying hours (average 2 hours), and 34 of these developed acute otitic barotrauma. This is shown in Table 3.

TABLE 3

*The relationship of previous flying experience to the incidence of acute otitic barotrauma as a disability*

Previous flying experience.	Total Subjects	Subjects who developed acute otitic barotrauma	Percentage of subjects who developed acute otitic barotrauma.
Nil .. .. .	591	55	9.3%
Previous experience 1-200 hours (average 2 hours) .. ..	409	34	8.3%

The difference between the two percentages is not significant and it appears that previous flying experience probably does not lessen the incidence of acute otitic barotrauma. This finding agrees with our clinical experience amongst operational aircrew personnel.

3 cadets who were unaffected during the test and 2 in whom acute otitic barotrauma was produced by recompression had previously experienced symptoms whilst flying.

## (3a) *History of any previous aural and/or upper respiratory complaints and/or operations.*

An analysis of the above is shown in Table 4.

TABLE 4  
Analysis of the histories of 1,000 eustachs

	No disability.			Total no disability.	Disability.		Totals.
	A. Unaffected—575 With symptoms but with no abnormal otoscopic signs—11.	B. Congested Drumheads. Without symptoms With mild symptoms relieved by auto- inflation—48.	C. Acute Otitic Barotrauma.				
Total series .. ..	586	325	89	911		1,000	
1. Previous acute suppurative otitis media ..	1	2	1	3		4	
2. Previous aural discharge ..	31	16	1	47		48	
3. Previous earache ..	44	30	17	74		91	
4. Previous deafness ..	5	11	2	16		18	
5. Previous aural operations ..	Mastoidectomy 3 Myringotomy 2 Removal of Polypus 1	1 } 2 } 3 }	Myringotomy 1	9		10	
6. Frequent colds ..	25	7	4	32		36	
7. "catarrh" ..	14	—	—	14		19	
8. Nasal obstruction ..	11	4	5	15		16	
9. Previous nasal operations ..	Proof puncture 4 S.M.R. 2 Antrostomy 2 Removal of polypus 3 Unknown 5	S.M.R. 3 Antrostomy 2 Removal of Polypus 1	—	23		23	
10. Frequent sore throats ..	150	1	—	5		5	
11. Removal of tonsils and/or adenoid ..	150	114	26	264		290	

Column A—Subjects unaffected.  
Column B—Subjects with congested drumheads.  
Column C—Subjects with acute otitic barotrauma.

## The Incidence of Acute Otitic Barotrauma

(Table 4—3a, 1, 2, 3, 4 and 5) *History of previous aural complaints and/or operations.*

Pain is a symptom which remains in a patient's memory and consequently the number of cadets shown in Table 4, 3, who gave a history of previous earache is probably fairly accurate. The majority of those who gave a history of (Table 4, 1) previous acute otitis media, (Table 4, 2) previous aural discharge, (Table 4, 4) previous deafness, and (Table 4, 5) previous aural operations, gave an additional history of earache, and many of these therefore have been recorded also in column 3 of Table 4.

An analysis of the subjects who gave a history of previous earache is shown in Table 5.

TABLE 5

*The relationship of a history of previous earache to the incidence of acute otitic barotrauma as a disability*

	Subjects with no disability	Subjects who developed acute otitic barotrauma
Total .. .. .	911	89
Subjects with a history of previous earache .. . . .	74	17
Percentage of subjects with a history of previous earache .. . . .	8.1%	19.1%

The difference between these percentages is significant, and it is therefore probable that subjects who give a history of previous aural complaints are more prone to develop acute otitic barotrauma (19.1 per cent.) than those who give no such history (8.1 per cent.)

(3a, 7). *History of recurrent nasal catarrh*

19 cadets gave a history of "nasal catarrh". It was considered that these subjects were suffering from recurrent subacute rhinitis or nasopharyngitis, as no evidence of anatomical abnormality or of a present acute infection was found at the time of examination. These cases are analysed in Table 6.

TABLE 6

*The relationship of a history of recurrent nasal "catarrh" to the incidence of acute otitic barotrauma as a disability*

	Subjects with no disability.	Subjects who developed acute otitic barotrauma
Total .. .. .	911	89
Subjects with a history of recurrent nasal "catarrh" .. . . .	14	5
Percentage of subjects with a history of recurrent nasal "catarrh" .. . . .	1.5%	5.6%



Although the numbers are small the difference in these percentages is probably significant; and it would appear that subjects who complain of recurrent nasal "catarrh" are more prone to develop acute otitic barotrauma (5.6 per cent.) than those who give no history of such a complaint (1.5 per cent.).

A history of the remaining conditions shown in Table 4 (6, 8, 9, 10 and 11) do not appear to be contributory factors to the production of acute otitic barotrauma.

(3b) *The relationship of a history of the presence of an active "cold in the head" and of the positive clinical findings of acute nasopharyngitis to the incidence of acute otitic barotrauma as a disability.*

It has been deemed advisable to consider these two possible contributory factors together. Table 7 shows the number of cadets who complained of a present "cold" and the total number of subjects considered to be suffering from nasopharyngitis is shown in Table 8, 6.

As recorded in Table 8, the incidence of acute otitic barotrauma as a disability is high in those subjects in whom examination revealed as excess of (Table 8, 5) post-nasal discharge and of mucus or mucopus in the nasal fossæ, and (Table 8, 8) dullness of the maxillary antra on transillumination. Consideration of these latter conditions is included in this paragraph, as the clinical findings were probably the result of an acute nasopharyngitis.

TABLE 7

*The relationship of a complaint of a present "cold" and of the clinical findings of acute nasopharyngitis to the incidence of acute otitic barotrauma as a disability*

	Total.	Subjects suffering from acute otitic barotrauma.	Percentage of subjects suffering from acute otitic barotrauma.
Subjects with no complaints ..	777	52	6.7%
Subjects with no positive clinical findings and no complaint of acute nasopharyngitis (Table 8) ..	742	43	5.7%
Subjects complaining of a present "cold" .. .. .	223	37	16.6%
Subjects suffering from acute nasopharyngitis (Table 8) .. .	258	46	17.8%

It will be seen that 16.6 per cent. of the subjects who complained of "cold" and 17.8 per cent. of those suffering from an acute upper respiratory infection developed acute otitic barotrauma. In those who did not complain and who were unaffected by acute nasopharyngitis the percentages were 6.7 and 5.7 per cent. The differences between these two sets of percentages are significant, and they demonstrate that a complaint of an active "cold" and/or the presence of an acute nasopharyngitis are contributory factors to the production of acute otitic barotrauma.

# The Incidence of Acute Otitic Barotrauma

TABLE 8  
Analysis of the abnormal clinical findings in 1 000 cadets

	No disability			Disability	Totals
	A Unaffected—575 With symptoms but with no abnormal otoscopic findings—11	B Congested Drumheads Without symptoms—277 relieved by auto inflation—48	Total no disability	C Acute Otitic Barotrauma	
Total series	586	325	911	89	1 000
1 Abnormal drumheads	100	67	167	20	187
2 Objective non patency of eustachian tube	34	46	80	30	110
3 Unhealthy hypertrophic tonsils and/or adenoid	5	7	12	4	16
4 Post nasal scarring	1	1	2	—	2
5 Post nasal discharge	13	13	26	13	39
6 Acute nasopharyngitis 1 c complaint of a cold and/or positive clinical findings	52	30	82	20	102
7 Obstructive deviation of nasal septum	136	76	212	46	258
	7	12	19	2	21

A—Subjects unaffected  
B—Subjects with congested drumheads  
C—Subjects with acute otitic barotrauma

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(3c) *The relationship of existing upper respiratory abnormalities as found on examination to the incidence of acute otitic barotrauma as a disability.*

Table 8 shows the abnormalities of the ear, nose and throat found on examination of 1,000 cadets.

(3c, 1) *The relationship of abnormal drumheads to the incidence of acute otitic barotrauma as a disability.*

Aviation Candidates Medical Boards reject many *candidates* who show evidence of "old healed otitis media with scarring and/or adhesions but without perforation" as permanently unfit for flying training. During the period August, 1941, to July, 1943, 1,246 candidates were rejected on these findings alone, although in 30.9 per cent. of them their hearing was up to the present standard. As a result of this selection no *cadets* used in this investigation exhibited gross changes of their drumheads.

One or other of the abnormalities shown in Table 9 was observed in the drumheads of 24 middle-ear clefts (20 subjects) affected by acute otitic barotrauma and in 253 drumheads (167 subjects) of unaffected middle-ear clefts.

TABLE 9

*The relationship of abnormality of the drumhead and of the type of abnormality of the drumhead to the incidence of acute otitic barotrauma as a disability*

Otoscopic appearances.	Total series.	Numbers and percentages of drumheads affected by acute otitic barotrauma.
Normal drumheads .. .. .	1,723	121 (7.0%)
Abnormal drumheads .. .. .	277	24 (8.6%)
Scarred drumheads (i.e. healed perforations) .. .. .	84	8 (9.5%)
Generalized or localized opacity or atrophy of the drumhead ..	145	12 (8.2%)
Plaques of the drumhead .. ..	35	3 (8.8%)
Mixed types of abnormalities of the drumhead .. .. .	13	1 (7.6%)

The differences in the percentages shown in the last column of Table 9 are not significant. It would appear therefore that the presence and type of abnormality of the drumheads as seen in *cadets* do not appreciably alter the chances of the onset of acute otitic barotrauma.

(3c, 2) *The relationship of objective non-patency of the eustachian tube to the incidence of acute otitic barotrauma as a disability.*

From Table 8 it may be seen that objective non-patency of the eustachian tube was present in 30 (33.7 per cent.) subjects who were affected by acute otitic barotrauma, and in 80 (8.7 per cent.) of those with no disability.

# The Incidence of Acute Otitic Barotrauma

The number of affected and unaffected middle-ear clefts in which objective patency or non-patency of the eustachian tube was recognized by the visual and/or auditory methods are shown in Table 10

TABLE 10

*The relationship of objective patency and non patency of the eustachian tubes to the incidence of acute otitic barotrauma as a disability*

	Objectively patent eustachian tubes	Objectively non patent eustachian tubes
Total middle ear clefts	1 851	149
Affected by acute otitic barotrauma	103	41
Percentage affected by acute otitic barotrauma	5.6%	27.5%

Table 10 demonstrates that middle ear clefts with objectively non-patent eustachian tubes are more frequently affected by acute otitic barotrauma (27.5 per cent) than those in which the tubes are objectively patent (5.6 per cent)

(3c, 3) *The relationship of unhealthy and/or hypertrophic tonsils and/or adenoid to the incidence of acute otitic barotrauma as a disability*

Although the numbers are small it would appear from Table 11 that the presence of unhealthy and/or hypertrophic tonsils and/or adenoid possibly contribute to the development of acute otitic barotrauma

TABLE 11

*The relationship of unhealthy and/or hypertrophic tonsils and/or adenoid to the incidence of acute otitic barotrauma as a disability*

	Subjects with no disability	Subjects affected by acute otitic barotrauma
Total	911	89
Subjects with unhealthy and/or hypertrophic tonsils and/or adenoid	12	4
Percentage of subjects with unhealthy and/or hypertrophic tonsils and/or adenoid	1.3%	4.4%

It is possible that the greater incidence of acute otitic barotrauma in the cadets with unhealthy and/or hypertrophic tonsils and/or adenoid as shown in Table 11 is due to tubal obstruction by adenoid and to nasopharyngitis which may recur as a sequel of the tonsillar sepsis

(3c, 4 and 7) *Post nasal scarring and obstructive deviations of the nasal septum* do not appear to be predisposing factors to the onset of acute otitic barotrauma

### 3d. Malocclusion

There are many references (<sup>1 2 3 4 5</sup>) in the dental literature to the ill-effects which are attributed to abnormal dental occlusion with special emphasis on impaired hearing in middle age. It has been suggested (<sup>6 7 8</sup>) that malocclusion is an important predisposing cause of otitic barotrauma. In the present investigation the dental aspect as a contributory cause to acute otitic barotrauma has been studied. 50 subjects who developed acute otitic barotrauma in the last 690 cadets tested were dentally inspected and classified.

Angle's method was used and Class I (Fig. 1) includes those cases in which the first permanent molars are in normal mediobuccal relationship but the anterior teeth show general or local irregularities of position; these may be subdivided, using Dr. Robert Cutler's classification.<sup>9</sup> Class 2 (Fig. 1) contains those cases in which the first permanent mandibular molars are in post-normal mediobuccal relationship to the corresponding maxillary molars; in Class 3 (Fig. 1) the first permanent mandibular

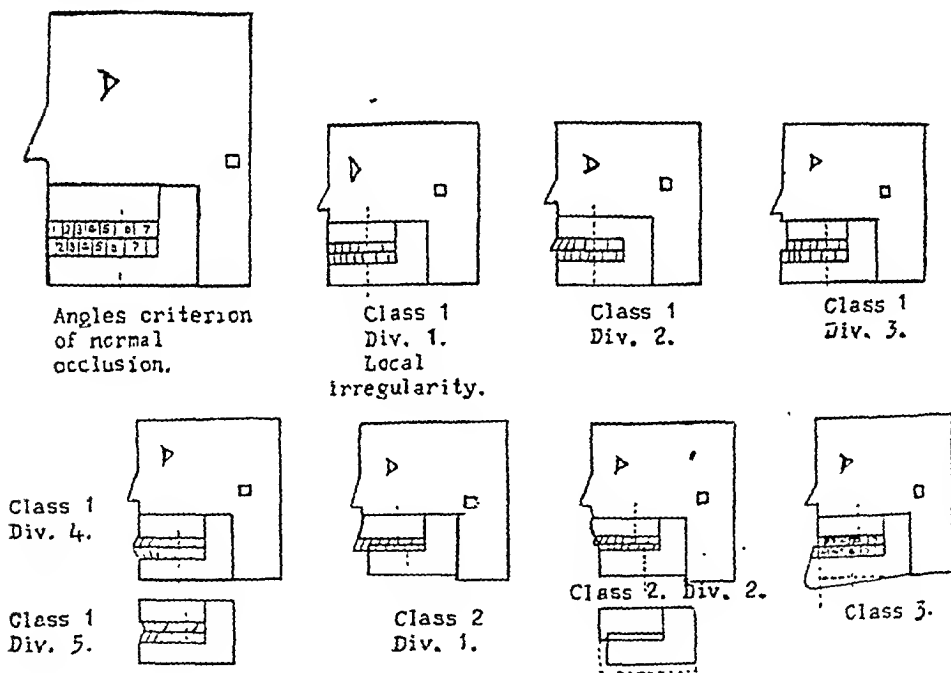


FIG. 1  
Classification of Malocclusion.  
(Cutler's modification of Angle's method.)

molars are in pre-normal relationship to the maxillary ones. Overclosure of the incisors, facial measurements, as used by Goodfriend, and missing teeth were also noted (Tables 12 and 13).

# The Incidence of Acute Otitic Barotrauma

An equal number of controls were similarly inspected and classified, these controls were taken at random throughout this series so that they were representative (Tables 12 and 13)

The subjects who developed acute otitic barotrauma and who had loss of intermaxillary distance (that is overclosure of the mandible) or retrusion of the mandible (Angle's Class 2) were recalled and the bite was opened anteriorly 0.5 centimetre (this is more than the average opening of the bite in the cases reported by Lowry) using small Paribar composition blocks mounted on a palatal wire frame between the molars. The distance between the gum margin of the upper and lower first incisors with the teeth in centric occlusion was measured with calipers, which were then opened 0.5 centimetre and the blocks of softened Paribar inserted. The subject was instructed to close on the blocks until the bite was opened anteriorly by 0.5 centimetre, and the blocks were then removed and cooled. Those subjects with malocclusion who developed acute otitic barotrauma on two or more occasions were retested under the same conditions with the bite in position (Table 14). X-rays were taken by Miss Hamilton, of the National Hospital, Queen Square, of left and right temporo-mandibular joints, open, closed and with the blocks in position, using a Lysholm skull table. Histories were taken to determine any of the symptoms which have been attributed to abnormal condylar position.

Temporo mandibular joint X-rays, left and right, open and closed, were also taken of a group of cadets with overclosure and of a second group with normal occlusion, no subjects of either group developed acute otitic barotrauma in the decompression chamber.

## Results

There were 50 cases of acute otitic barotrauma while decompression 690 subjects, i.e. an incidence of 7.2 per cent.

TABLE 12

*Analysis of 50 subjects who developed acute otitic barotrauma and of 50 control subjects*

	Subjects who developed acute otitic barotrauma (50)	Control Subjects (50)
Normal occlusion	12%	16%
Angle's Class 1	48%	44%
Angle's Class 2	22%	28%
Angle's Class 3	18%	12%
Incisal overclosure	42% of which 9% + + + 34% + + 48% + 9% mild	48% of which 00% + + + 25% + + 48% + 27% mild
Total number of teeth missing	266	283
Number of molars missing	131	121
Colds	78%	40%
Average age in years	21	19

## E. D. D. Dickson

Assuming that the two groups are representative of cases and controls, the percentage of 690 cadets who developed acute otitic barotrauma are :

With normal occlusion .. ..	5.6 per cent.
With malocclusion .. ..	7.5 per cent.

Goodfriend measured the distance between the outer canthus of the eye and the angle (Fig. 2A) of the mouth and stated that normally this is between 60-70 mm. and equals the distance between the subnasion and the menton (Fig. 2B) ; he used these measurements to assess the loss of intermaxillary distance.

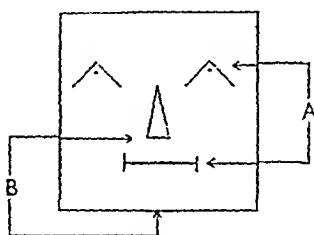


FIG. 2.

Goodfriend's method of measuring the intermaxillary distance.

TABLE 13

*Comparison of intermaxillary distance of 50 subjects who developed acute otitic barotrauma and of 50 controls*

	Subjects who developed acute otitic barotrauma. (50)	Control subjects. (50)
A equals B .. ..	30%	24%
A greater than B .. ..	38%	58%
A less than B .. ..	32%	18%

It will be seen that there is very little variation between the figures for the subjects who developed acute otitic barotrauma and the controls as shown in Table 12. The incidence rates of acute otitic barotrauma for normal and malocclusion show no significant variation.

If overclosure is a factor in acute otitic barotrauma, there should be more molars missing in the subjects who developed acute otitic barotrauma but this is not shown in the present investigation. Although the figures for incisal overclosure show more severe cases and fewer mild cases in the subjects who developed acute otitic barotrauma, the numbers are too small to be of statistical significance.

From a study of the literature it might be expected that most cases of acute otitic barotrauma would show post-normal position of the mandible (Angle, Class 2) ; however, the majority of the subjects who developed acute otitic barotrauma in the present experiment showed normal antero-posterior position of the mandible.

# The Incidence of Acute Otitic Barotrauma

TABLE 14

*Analysis of 7 subjects with malocclusion who developed acute otitic barotrauma For various reasons it was impossible to complete the bite block tests in a larger series*

CASE NUMBER	1	2	3	4	5	6	7
Angle's Class Division (Fig. 1)	1	1	1	1	1	2	2
	5	1	2	1	1	1	1
Incisal overclosure	+++	+	+	+	+	0	+
Teeth missing	$\frac{6}{6\frac{1}{4}}$	$\frac{6\frac{1}{2}}{6\frac{1}{4}}$	$\frac{6}{76\frac{1}{2}}$	$\frac{6}{77}$	$\frac{6\frac{1}{2}}{6\frac{1}{2}}$	$\frac{6\frac{1}{2}}{6\frac{1}{2}}$	$\frac{2}{2}$
Distance A in mm (Fig. 2)	70	76	76	75	71	76	72
B	71	77	80	68	73	75	65
History of							
(1) Difficulty in swallowing	—	—	—	—	—	—	—
Impaired hearing	—	—	once with severe cold	—	—	—	—
Tinnitus	—	—	—	—	—	occasionally	—
Dizziness	—	—	—	—	rarely in summer	do	slight eye strain
Clicking of temporomandibular joint	yes	yes	—	—	—	yes	yes
( ) Dislocation of temporomandibular joint	—	—	—	—	—	—	—
Headache	—	occasionally in forehead	—	—	occasionally in sun	occasionally above and behind left eye	—
(3) Burning sensation of nose throat or tongue	—	—	—	—	—	—	—
(4) Dryness of mouth	—	—	—	—	—	—	—
Sore throat	occasionally	sometimes	—	—	very seldom	—	—
Catarrh	—	—	very rare	—	—	occasionally	slight
(5) Earache	—	—	—	—	—	—	—
Decompression tests							
First	Fail (cold)	Fail	Fail (cold)	Fail (cold)	Fail (cold)	Fail (cold)	Fail (cold)
Second	Fail	Fail	Fail	Fail	Fail (cold)	Fail	Fail (cold)
Third	Pass	Fail	Fail	Fail	Fail	Fail	Pass
Opened with bite block	Pass	Fail (slight cold)	Fail	Pass	Pass (cold)	Fail	Fail

From Table 13 it is seen that measurement "A equals B" occurs in 30 per cent of subjects who developed acute otitic barotrauma. From this we might expect that 30 per cent of the group had normal occlusion, but from clinical examination of the same group as shown in Table 12 only 12 per cent had normal occlusion. The same discrepancy can be shown when comparing the other figures in the two tables. There is other evidence also that Goodfriend's method of estimating the loss of intermaxillary distance is not reliable.



Clicking of the temporo-mandibular joint occurred in 4 of the 7 cases with overclosure or retrusion. This symptom is said to denote abnormality of the joint and signify suitability for successful treatment by repositioning the mandible but three out of four cases in the present series failed to get relief with the bite blocks in position (Table 14).

It is not desirable to include a detailed study of the X-rays in this report but tremendous variation was noticed in the condyles, glenoid cavities, articular eminences, thickness of the articular discs and position of the condyles in centric occlusion. Opening the bite anteriorly 0.5 centimetre appears to move the condyle only very slightly downwards and forwards, and it is difficult to understand how this movement can relieve any bunching up of soft tissues which is said to press upon the eustachian tube in these cases; it is possible that a wider opening of the bite may create considerable difficulties in intercommunication as intelligibility is at about its lowest useful limit with the blocks in use.

#### 4. *The incidence of sinus barotrauma*

18 (1.8 per cent. of total series) cadets developed sinus barotrauma. In 2 cases it was associated with acute otitic barotrauma, and in 1 with dental barotrauma. 17 subjects complained of frontal pain and 1 of pain in his cheek.

6 of the above cadets were suffering from acute nasopharyngitis at the time of the test.

6 of the 18 cadets showed dullness of the antrum on transillumination and radiological signs of maxillary and/or frontal sinus abnormality were present in 7 of the 10 who were X-rayed. 1 cadet who suffered from sinus barotrauma was submitted to proof puncture of his antrum and blood was withdrawn from the cavity.

#### 5. *The incidence of dental barotrauma*

Amongst the 1,000 men who were decompressed to 10,000 ft. there were 13 (1.3 per cent.) cases of dental pain in the decompression chamber.

The onset of pain was usually during decompression round about a pressure corresponding to an altitude of 5,000 ft. The pain was relieved during descent except in 1 case in which it persisted for 24 hours until relieved by extraction.

TABLE 15  
*Analysis of 13 cases of dental barotrauma*

Recently filled	..	..	..	..	8 cases.
Average time since last filling	..	..	..	..	5.7 weeks.
Caries	..	..	..	..	6 cases.
Apical area	..	..	..	..	1 case
Subacute abscess	..	..	..	..	1 case.
Incisors	..	..	..	..	2 cases.
Canine	..	..	..	..	1 case.
Premolars	..	..	..	..	4 cases.
Molars	..	..	..	..	6 cases.

# The Incidence of Acute Otitic Barotrauma

These figures concur in general with previously reported but unpublished data from the R A F Physiological Laboratory of 89 cases of dental barotrauma occurring during decompression, and of 180 cases occurring while flying

## 6 *The incidence of barotraumatic changes in general (disabling and non disabling) in the middle ear clefts as a pathological entity on 1,000 air-crew cadets during the decompression test*

As mentioned earlier, in addition to the 89 cases of acute otitic barotrauma, 325 cadets developed a varying degree of manifest vascular engorgement of their drumheads which was accompanied by mild or transient symptoms in 48 cases (Tables 4 and 8, Column B) In none of these, however, were the signs and/or symptoms sufficient to constitute a disability

That these congestive changes were due to pressure variations (barotrauma) and not to overzealous attempts to auto inflate or to the oscillations of the drumhead caused by condensation and rarefaction of air in the middle ear is shown by the following clinical observations (*a* and *b*) and by the control experiments (*c* and *d*)

- (a) 159 of the cadets who developed congestion of their drumheads were examined at intervals following the test In 108 cases the congestion persisted for 24 hours, in 29 for 36 hours in 16 for 48 hours, and in 6 for 4 days In 7 cases residual hæmorrhage along the handle of the malleus was obvious after the congestion had resolved
- (b) 75 cadets who used swallowing only and 10 who used swallowing combined with jaw movements as a means of opening their tubes, developed congestion of one or both drumheads (Table 16, Column B)

TABLE 16  
*Methods adopted by 1 000 cadets to ventilate their middle ear clefts*

Method of equalization	No disability			Acute otitic barotrauma	Total
	A Unaffected 586	B Congested 325	Total 911		
Swallowing only	171	75	246	3	249
Swallowing and Valsalva	329	229	558	84	642
Swallowing and jaw movements	51	10	61	2	63
Swallowing Valsalva and jaw movements	35	11	46	—	46

No conclusions as to the most effective method of middle ear ventilation can be drawn from Table 16 since many candidates tried all methods

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as an experiment and *all who complained* of symptoms were instructed to perform Valsalva's manœuvre.

- (c) A control series of 50 cadets with normal drumheads and visibly patent eustachian tubes were supervised whilst they performed Valsalva's manœuvre nine times at twenty second intervals. None of these developed congestion of either of their drumheads.
- (d) A further control series of 50 cadets with normal drumheads and visibly patent eustachian tubes were subjected to tympanic massage by vigorous condensation and rarefaction of air in the external auditory meatus 15 times with a Siegle's speculum. 53 drumheads shows no change; 47 developed slight congestion which persisted for less than 3 minutes and in another for 15 minutes. In no case was any residual hæmorrhage observed.

The observations and investigations, (a), (b), (c) and (d), therefore, demonstrate that the tympanic congestion produced by the decompression test in the above-mentioned 325 cadets was probably due to pressure differences and not to other mechanical trauma of the drumhead.

The separation of the 89 cases of "acute otitic barotrauma" from the 325 cadets who showed congestion of their drumheads is based purely on clinical findings; in the former the greater severity and persistence of the *symptoms* constituted a disability, whereas in the latter no disability was considered to be present.

From a pathological viewpoint, however, the entire series of 414 cadets (89 with acute otitic barotrauma and 325 with congested drumheads) suffered from a varying degree of barotraumatic change in their middle-ear clefts.

As would be expected therefore similar conditions which may be considered as contributory factors to the production of acute otitic barotrauma appear to contribute also to the development of congestion of the drumhead. This is shown in Tables 17, 18 and 19.

### (7) *The objective methods of detecting patency of the eustachian tube*

Patency of the eustachian tube may be recognized by auscultation or by the observation of movement of the drumhead during entry of air into the middle-ear cavity.

In the present series it has been found that patency of the tube can be diagnosed more frequently by the visual than by the auditory method—although both methods should be employed for diagnosis. This finding agrees with our previous clinical observations.

Table 20 shows a comparison of the results of the two methods in :

A—Total series of 2,000 middle-ear clefts.

B—Total series of 1,402 unaffected middle-ear clefts.

C—Total series of 598 congested middle-ear clefts.

D—Total series of 144 middle-ear clefts affected by acute otitic barotrauma.

# The Incidence of Acute Otitic Barotrauma

TABLE 17

*The relationship of a history of previous earache to the incidence of congestion of the drumhead (including the 89 cases of acute otitic barotrauma)*

	Subjects with unaffected drumheads	Subjects with congested drumheads
Total	586	414
Subjects who gave a history of previous earache	44	47
Percentage of subjects who gave a history of previous earache	7.5%	11.3%

TABLE 18

*The relationship of acute nasopharyngitis to the incidence of congestion of the drumheads (including the 89 cases of acute otitic barotrauma)*

	Total	Subjects who developed congestion of their drumheads	Percentage of subjects who developed congestion of their drumheads
Subjects unaffected	742	292	39.4%
Subjects suffering from acute nasopharyngitis	258	122	47.3%

TABLE 19

*The relationship of objective non-patency of the eustachian tube to the incidence of congestion of the drumhead (including 89 cases of acute otitic barotrauma)*

	Middle ear clefts with objectively patent eustachian tubes	Middle ear clefts with objectively non patent eustachian tubes
Total	1851	149
Middle ear clefts with congested drumheads	499	99
Percentage of middle ear clefts with congested drumheads	27.0%	66.4%

It will be seen that in series B, in which there was presumably adequate tubal ventilation, visual recognition of air entry into the tympanum was positive in 95.7 per cent of the middle-ear clefts, whereas auscultation was positive in 52.8 per cent only. These percentages are less in series C and D in which tubal ventilation was less adequate and conversely the percentages of objectively non-patent tubes increases in series C and D.

(8) *The minimal nasopharyngeal pressures required to cause air entry into the middle ear cavity*

An attempt was made to estimate the minimal nasopharyngeal pressure required during Valsalva's manoeuvre to cause air-entry into the middle ear as recognized by visible movement of the drumhead in the

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TABLE 20

	Total middle ear clefts.	Objectively patent.			Objectively non-patent.	Percentages.
		Visibly + Audibly -	Visibly + Audibly +	Visibly - Audibly +	Visibly - Audibly -	
A. Total series	2,000	855	980	16	149	Visibly + :91.7% Audibly + :49.8% Negative : 7.4%
B. Unaffected	1,402	611	731	10	50	Visibly + :95.7% Audibly + :52.8% Negative : 3.6%
C. Congested	598	244	249	6	99	Visibly + :82.4% Audibly + :42.6% Negative :16.6%
D. Acute otitic barotrauma	144	52	46	5	41	Visibly + :73.5% Audibly + :35.9% Negative :28.4%

1,000 cadets of the series. The pressures were measured by a mercury manometer which was connected with an accurately fitting nosepiece. The subjects were instructed to perform Valsalva's manœuvre, and as soon as movement of the drumhead was observed the reading on the manometer was taken. The procedure was carried out as carefully as possible and appeared to be fairly accurate for pressure below 80 mm. Hg. Above this pressure the measurements were in many cases not accurate as the subjects were apt to make their efforts too explosive.

The numbers and percentages of the middle-ear clefts in the various pressure groups are tabulated in Table 21.

A—Total series of middle-ear clefts.

B—Total series of unaffected middle-ear clefts.

C—Total series of congested middle-ear clefts.

D—Total series of middle-ear clefts affected by acute otitic barotrauma.

Table 21, Column D, demonstrates that acute otitic barotrauma is more prone to develop in the higher pressure groups (61 mm. Hg and over).

(9) *The "practice effect" on the objectively successful performance of Valsalva's manœuvre.*

There is no doubt that ignorance of and inaptitude in the proper performance of Valsalva's manœuvre is common and that in some subjects these factors do account for the failure of ventilation of the middle-ear clefts during flight.

41 eustachian tubes of the 89 subjects suffering from acute otitic barotrauma were objectively non-patent before the decompression test

# The Incidence of Acute Otitic Barotrauma

TABLE 21

*The numbers and percentages of middle-ear clefts in the various groups of minimal pressure (in mm Hg) required to cause visible air entry into the middle ear by Valsalva's method*

	Total	Minimal pressure in mm Hg required to cause air entry into the middle ear.					
		1 0-10 mm	2 11-20 mm	3 21-40 mm	4 41-60 mm	5 61-80 mm	6 81 mm
A Total series middle-ear clefts	2,000	26	116	697	588	352	221
B Unaffected middle ear clefts	1,402	24 (92.3%)	86 (74.2%)	537 (77.1%)	430 (73.2%)	209 (59.1%)	116 (52.5%)
C Congested middle-ear clefts	598	2 (7.7%)	30 (25.8%)	160 (22.9%)	158 (26.8%)	143 (40.9%)	105 (47.5%)
D Middle-ear clefts affected by acute otitic barotrauma	144	—	3 (2.5%)	26 (3.6%)	32 (5.4%)	46 (13.0%)	37 (16.7%)

(Table 20). Table 22 demonstrates that 9 of these eustachian tubes were visibly patent after the first test, a further 14 after the second test and 3 after the third test, i.e. 27 (65.8 per cent.) of the previously objectively non-patent eustachian tubes became visibly patent possibly as a result of practice.

TABLE 22

*To demonstrate the effect of practice on the successful performance of Valsalva's manœuvre*

	Became visibly patent	Remained visibly non-patent without symptoms	Remained visibly non patent with symptoms
After first test	9	5	27
After second test	14	3	10
After third test	4	—	6

## Analysis of 89 Cases of Acute Otitic Barotrauma

### *Monaural and binaural symptoms*

67 (75.3 per cent.) cadets complained of symptoms in one ear only and 22 (24.7 per cent.) stated that both ears were affected. In several cadets who complained of one ear only there were positive objective "findings" in the ear which did not give rise to symptoms. In actual practice amongst a large series of operational aircrew personnel affected

by acute otitic barotrauma we have found that the numbers who complained of monaural and of binaural symptoms were almost equal.

*Pressure differences at which complaint of symptoms was made*

9 cadets complained of pain on recompression during the trial test, i.e. at various times during recompression for a pressure corresponding to an altitude of 4,000 ft. (656.4 mm. Hg) to ground level pressure (760.0 mm. Hg).

The remaining 80 cadets complained of symptoms (pain and/or deafness) at pressures and the corresponding altitudes, shown in Table 23.

TABLE 23

*The pressure at which complaint of symptoms was made by 80 cadets*

Pressures at which complaint of symptoms was made	522.6	564.4	609.0	632.4	656.4	681.0	706.6	733.0	760.0
	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg
Corresponding altitude	10,000 ft (Ascent)	8,000 ft	6,000 ft	5,000 ft	4,000 ft	3,000 ft	2,000 ft	1,000 ft	Ground level
		←				→			
Corresponding loss of height	nil.	2,000 ft	4,000 ft	5,000 ft	6,000 ft	7,000 ft	8,000 ft	9,000 ft	10,000 ft.
Possible maximum differential pressures in the middle ear	737.4	41.8	86.4	109.8	133.8	158.4	184.0	210.4	237
	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg	mm Hg
Number of subjects who complained	1 (1.2%)	1 (1.2%)	2 (2.5%)	7 (8.7%)	12 (15.0%)	21 (26.2%)	18 (22.5%)	9 (11.2%)	9 (11.2%)

Table 23 demonstrates that 76 of the 80 cadets who complained of symptoms during recompression (descent) had a possible negative pressure differential of 110 mm. Hg or more in their middle ears.

1 cadet complained of pain on decompression (ascent) to a pressure of 522.6 mm. Hg (10,000 ft. altitude). Occasionally subjects who complain of pain during ascent in aircraft, which commonly begins about 8,000 ft. (564.4 mm. Hg) altitude, are seen amongst flying personnel.

*Symptoms*

71 cadets complained of earache, 10 complained of deafness and 3 of pressure and fullness in the ears. The remaining 5 complained respectively of numbness, blockage, tightness, stiffness and of a burning sensation in the ears. 4 of the 9 cadets shown in the last column of Table 23, who manifested symptoms on reaching ground level pressure complained of pain and the remaining 5 of deafness. 8 cadets complained of pain and 1 of deafness during recompression on the trial test from a pressure corresponding to 4,000 ft. 15 cadets stated that their symptoms were relieved by immediate decompression (re-ascent) and 3 were unrelieved.

*Otoscopic appearances*

Most of the affected ears showed a varying degree of congestion and invagination of the drumhead. Effusion was noted after the first test

# The Incidence of Acute Otitic Barotrauma

in 7 middle ears, in 1 after both the first and second tests, and in 5 after the second test (i.e. on 14 occasions). In all cases the effusion was visible immediately after leaving the chamber.

In no case was the effusion visible when the cadets were examined 18 hours later. 1 cadet was found to be suffering from a hæmato-tympanum when he left the chamber, and 1 developed manifest acute suppurative otitis media two days after the test. As mentioned earlier, 1 cadet, not included in the above, showed an effusion in his middle ear but would admit to no symptoms. In 4 cadets residual interstitial hæmorrhages of the drumhead were visible after the congestion had resolved.

## *The effect of the administration of amyl nitrate*

Inhalations of 3 min. amyl nitrate were administered to 9 cadets suffering from acute otitic barotrauma and the results were inconclusive as shown in Table 24.

TABLE 24  
*Subjective and objective relief after inhalation of amyl nitrate*

Cadet	Subjective relief	Objective relief
1	+	—
2	+	—
3	+	—
4	—	?
5	—	—
6	not stated	+
7	—	—
8	not stated	?
9	not stated	+

## Summary and Conclusions

(1) Pain and/or loss of hearing accompanied by abnormal otoscopic changes which result from difference between the atmospheric and intra tympanic pressure constitute the syndrome of acute otitic barotrauma.

(2) The syndrome is produced during flight or in a decompression chamber by alterations in the atmospheric pressure in the presence of some personal contributory factor.

(3) The contributory factors may be either temporary or persistent and they vary from ignorance of the correct methods of middle ear ventilation to pathological obstruction of the eustachian tube.

(4) From the present investigation the following are considered to be contributory factors in the production of the syndrome.

- (a) Ignorance of the methods of middle ear ventilation. Of 41 middle ear clefts with objectively non patent eustachian tubes and affected by acute otitic barotrauma 27 (65.8 per cent) became objectively patent probably as a result of practice and 23 of these were unaffected in subsequent tests.



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- (b) A history of previous earache, deafness and/or aural discharge.
- (c) A complaint of a present "cold" and/or the clinical findings of an acute upper respiratory infection.
- (d) Objective non-patency of the eustachian tube.
- (e) A history of recurrent nasal "catarrh" and the clinical findings of unhealthy and/or enlarged tonsils and/or adenoid are possible factors.

(5) In many cases no contributory factor was discoverable.

In 4 subjects (57.1 per cent.) only of the 7 who failed in the three tests was there a recognizable contributory factor—i.e. 3 gave a history of a previous aural complaint and in 3 objective non-patency of the eustachian tube was present as shown below (Table 25).

TABLE 25

*Showing the presence or absence of recognizable contributory factors to acute otitic barotrauma in 7 subjects*

Subjects who failed in the three tests	Affected ear.	Manifest possible contributory factor.
1	R	Deafness 2 years ago Objective non-patency of tube.
2	L	Objective non-patency of tube
3	L	Earache as a child
4	R.	Earache as a child Objective non-patency of tube.
5	L	Nil.
6	R and L	Nil
7	R.	Nil.

It is possible that some undetectable physiological contributory factor (e.g. weakness of the muscles which open the eustachian tube, etc.) was present in the remaining 3 subjects (42.9 per cent.)

(6) 89 (8.9 per cent.) subjects developed acute otitic barotrauma. In 88 (8.8 per cent.) the symptoms occurred during recompression (descent) and in 1 (0.1 per cent.) during decompression (ascent). It is considered probable that the percentage of subjects who developed acute otitic barotrauma would have been considerably higher if the subjects had not been thoroughly instructed previously in the methods of ventilation of the middle-ear cleft.

There is some experimental evidence that the syndrome may develop during *ascent* in aircraft.

7 (0.7 per cent.) cadets failed to pass three consecutive tests at from seven to ten day intervals and these were regarded as liable to develop acute otitic barotrauma on every occasion when subjected to pressure variations. Owing to the smallness of the last percentage (0.7 per cent.) the adoption of a routine rest in the decompression chamber as a means of selection of aircrew *candidates* is not considered justifiable.

## The Incidence of Acute Otitic Barotrauma

(7) 74 cadets complained of earache, 10 of deafness and 5 of "fullness" "tightness", "pressure", etc., in their ears. Pain is not an inevitable symptom of the syndrome. It was a complaint in only 83.0 per cent of the cases. The symptoms were monaural in 75.3 per cent and binaural in 24.7 per cent of the cases. This finding does not correspond to that amongst flying personnel, in which the percentages of monaural and binaural symptoms are almost equal.

(8) 11 subjects complained of symptoms but they exhibited no abnormal otoscopic signs and Valsalva's manœuvre was visibly positive. It is not uncommon to examine similar cases in flying personnel in many of whom there is some underlying psychological cause of the symptoms.

(9) 76 subjects (85.3 per cent) complained of symptoms when the possible maximum negative pressure in the middle ear cavities varied from 110.0 mm Hg to 237.4 mm Hg—i.e. a loss of height varying from 5,000 ft to 10,000 ft, with an unopened eustachian tube. 12 (13.4 per cent) subjects complained with a possible maximum negative middle-ear pressure of 103.6—i.e. a loss of height of not more than 4,000 ft.

1 (1.1 per cent) subject developed symptoms after decompression to 522.6 mm Hg pressure, when there was a possible maximum positive pressure in the middle ear of 237.4 mm Hg—i.e. an ascent from ground level to 10,000 ft with an unopened eustachian tube. The amount of difference between the atmospheric and intratympanic pressures necessary to cause symptoms during loss of height is an individual peculiarity, and there is no fixed pressure differential at which symptoms may occur during ascent.

(10) All affected ear clefts showed some degree of congestion of the drumhead and in many the drumhead was invaginated. Effusion was seen on 15 occasions immediately after the subjects left the chamber. 1 of the subjects with manifest effusion in his middle ear would admit to no symptoms, probably owing to anxiety that such an admission might interfere with his flying career.

These effusions were characterized by the rapidity of their formation and of their disappearance. In all of the subjects the effusion had disappeared when they were examined 18 hours later. In actual practice amongst flying personnel we have observed cases in which the effusion has been visible for as long as 4 days.

It appears that effusion is a common occurrence in cases of acute otitic barotrauma but its existence is easily overlooked owing to its rapid disappearance. 1 subject appeared to have a hæmato-tympanum and 1 developed acute suppurative otitis media two days after the test. Residual interstitial hæmorrhages were visible in 4 drumheads after the congestion had subsided.

(11) Previous flying experience averaging two hours' duration does not appear to lessen the incidence of acute otitic barotrauma.

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(12) The degree and type of abnormality of the drumhead as seen in aircrew *cadets* does not predispose to acute otitic barotrauma. None of these abnormalities were very gross as the cadets had already been selected from the aircrew *candidates*. No definite opinion therefore can be expressed on the effect of the more gross abnormalities as contributory factors, but the present findings suggest that scarring even of a gross nature would not predispose to the production of acute otitic barotrauma.

(13) From this limited investigation it is suggested that :

- (a) Malocclusion of the teeth does not contribute to the onset of acute otitic barotrauma.
- (b) The facial measurements used are entirely unreliable for determining overclosure of the mandible.
- (c) The temporo-mandibular joints exhibit very great radiological variation—even in the same individual.
- (d) Opening of the bite to near the limit of intelligibility of speech on the intercommunication system produces very little change in condylar position.

(14) In addition to the 89 (8.9 per cent.) subjects who developed acute otitic barotrauma, 325 (32.5 per cent.) subjects developed congestion of one or both drumheads with or without mild transient symptoms. There is clinical and experimental evidence that this congestion was due to inadequate ventilation of the middle-ear cleft (barotrauma).

(15) A comparison has been made of the methods employed to ascertain that air entered the middle ear during auto-inflation.

- (a) Subjective—576 subjects were interrogated as to their subjective sensations during Valsalva's manœuvre—i.e. whether air was felt to enter into both ears simultaneously or into one ear before the other, and the replies were compared with the nasopharyngeal manometric pressures required to cause visible air entry into the middle ears. The findings agreed only in 70.3 per cent. of subjects, so that in 29.7 per cent. of subjects the subjective sensations may be considered unreliable evidence of successful auto-inflation.
- (b) Objective—A comparison was made of the visual and auscultatory methods of recognition of successful air entry into the middle ear. Of the total series of 2,000 middle ears, air entry was positive as shown by movement of the drumhead in 91.7 per cent. and by auscultation in 49.8 per cent. Of the middle-ear clefts unaffected by any barotraumatic changes 95.7 per cent. eustachian tubes were visibly patent and 52.8 per cent. audibly. Of those affected by acute otitic barotrauma 73.5 per cent. were visibly patent and 35.9 per cent. audibly patent. The visual

# The Incidence of Acute Otitic Barotrauma

method of detection of successful air-entry into the middle ear is the more frequently recognizable of the two methods

Objective patency of the eustachian tube does not necessarily mean that a subject can adequately ventilate his middle ears during flight, and *vice versa*

(16) Immediate treatment of acute otitic barotrauma by inhalations of amyl nitrate has had no beneficial effect

(17) 18 (18 per cent) subjects developed sinus barotrauma

(18) Dental barotrauma has an incidence of about 1 per cent. The onset is usually during ascent (at an average pressure corresponding to 5,000 ft altitude in this series of cases), while relief is commonly obtained on descent. Pain occurs frequently in recently filled teeth, while caries is the next most important factor. Molars are the most commonly affected teeth.

## Recommendations

(1) Subjects who give a history of previous earache, deafness and/or aural discharge, of recurrent nasal catarrh and those with objectively non-patent eustachian tubes should be submitted to a test in the decompression chamber before acceptance for aircrew duties.

(2) Subjects with unhealthy and/or enlarged tonsils and/or adenoids should be advised to submit to operative treatment before acceptance for aircrew duties.

(3) Scarred drumheads and healed perforations are not contributory factors to the production of acute otitic barotrauma. Such abnormalities of the drumhead should *not* be regarded as reason for rejection for aircrew duties provided that the hearing reaches the present standard or any future standard that may be introduced.

(4) No aircrew personnel should be permitted to fly whilst suffering from an acute respiratory infection.

(5) The visual method of recognition of air entry into the tympanum during inflation is the most reliable.

(6) It is recommended that those subjects who suffer from recurring acute otitic barotrauma and who have gross malocclusion should be given full medical treatment and advice and be supplied with an acrylic onlay or bite to be used if no improvement of their condition is forthcoming so that this treatment may be given an extended trial, it is considered imperative that this be carried out carefully, with radiological control, as in the present investigation, it is likely that any improvement then noted will be due to the "repositioning of the mandible" or the "opening of the bite."

## APPENDIX I

INVESTIGATION INTO THE INCIDENCE OF OTITIC AND SINUS  
BAROTRAUMA AMONG AIRCREW CADETS

## A.—SCHEME OF INVESTIGATION

Name..... Age..... Occupation.....

Any previous flying experience.....

*History :*

*Aural* Previous discharge.  
Deafness, past or present.  
Earache.  
Operations.

*Nasal* Frequent colds.  
Catarrh.  
Difficulty with breathing.  
Operations.

*Throat* Frequency of sore throats.  
Operations.

*Examination :*

*Aural* Tympanic membranes (noting degree, R.  
site and type of scarring, etc.). L.

Hearing—R. L.

Valsalva—ascertain if performed properly  
and observe air entry :

(a) mobility of membranes R.

L.

(b) auscultation R.

L.

Manometric pressure. R.  
L.

*Nasopharynx :*

Post-nasal catarrh or discharge.

Adenoid—absent or present.

Scarring—post-operative.

*Nose* Presence of pus or mucopus.

Mucosal changes or other abnormalities.

Airway—clear or obstructed.

Transillumination.

*Throat*—Tonsils—present or absent.

*General impression of candidate.*

## DECOMPRESSION TEST :

1. Instruction into proper way of performing auto-inflation, e.g., Valsalva, swallowing.
2. Trial run in chamber up to 4,000 ft. to accustom candidate to aural sensations. Descent 2,000 ft. per minute in two equal stages.

R



L



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3. Ascent to 10,000 ft. at 3,000 ft. per minute.  
Symptoms, if any  $\left\{ \begin{array}{l} \text{Ears.} \\ \text{Sinuses.} \end{array} \right.$   
At which height.
4. Descent to 2,000 ft. at 3,000 ft. per minute, progressively increasing to 4,000 ft. to ground level.  
Symptoms, if any  $\left\{ \begin{array}{l} \text{Ears.} \\ \text{Sinuses.} \end{array} \right.$   
Degree—severe, moderate, slight.  
At which height.
5. What methods adopted by candidate to equalize intratympanic pressure :  
(a) Valsalva.  
(b) Swallowing.
6. Otoscopic examination and completion of run in decompression chamber :  
Appearances of tympanic membranes—  
(a) Invaginated.  
(b) Injected.
7. Test hearing in those experiencing pain within 2 hours.
8. Retest candidates in whom symptoms arose in about 7 days.

REMARKS :

RETEST RESULTS :

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## CLINICAL RECORD

### EXTRADURAL ABSCESS FOLLOWING ON A CURED OTITIS MEDIA

By W. S. THACKER NEVILLE (Harrogate)

M.M., aged 42, on *January 11th*, 1944, came with a boil in the left ear and a red tympanic membrane with a central perforation, and a discharge which had been present one month. The left ear showed loss of low notes up to 64 d.v. the other tones being heard normally, whilst the right ear showed almost complete destruction of the tympanic membrane, and a discharge which had been present for four years. Tuning fork tests on the right ear showed deafness for all notes up to 2048 d.v., and a shortened bone conduction.

I gave the right ear six zinc ionizations between *January 18th* and *February 11th*, and the left ear two ionizations in January, whilst at home the patient used acriviolet one per cent. in twenty per cent. alcohol, after cleaning the ear with cotton covered probes. The right ear became dry after six ionizations, and the left after two ionizations. The ears remained well until *November 25th*, when the patient returned with pain in the right ear and acute eczema of the external auditory meatus, secondary to a return of the otitis media. I gave him Calamine lotion and acriviolet drops for home use, and administered ultra-short wave for twenty minutes to ease the pain on three occasions in November. On *December 1st*, the eczema being cured, I prescribed boric iodine powder for home use, and as the patient now complained of severe frontal and occipital pain, I administered ultra-short wave with the large electrode. The ear ceased to discharge by *December 12th*, but the frontal and occipital pain continued to incapacitate the patient from work, and was not relieved by ultra-short wave, so on *December 19th* I put the patient in a nursing home and asked Dr. Fothergill to take an X-ray of the mastoid processes.

Dr. Fothergill reported that the left mastoid was normal, whilst the right mastoid cells were completely obliterated and that there was gross sclerosis of the whole petrous bone, and the appearance suggested a long-standing right mastoiditis. The evening temperature on *December 19th* was 101° F.

On *December 20th* I operated, and found the mastoid was ivory-like in consistence, and no pus was present in the antrum, nor in the middle ear, so I removed the bone between the antrum and cerebrum and immediately there was a gush of pus, so removing more bone I drained this extradural abscess.

After filling the wound with sulphonamide powder I sutured it, draining through the external auditory meatus. The following day the patient was completely free from pain, so that two days after the operation he got out of bed, and dressed, and in a week he went out for a short walk. He left the nursing home three weeks, and returned to work four weeks, after the operation.

The interest of the case consists in the cure of the otitis media by ionization, yet the spread of infection to the extradural space.

# SOCIETIES' PROCEEDINGS

## ROYAL SOCIETY OF MEDICINE—SECTION OF OTOTOLOGY

May 5th, 1944

President—T. B. JOHNSON, M.D.

### Discussion on the Use and Misuse of Sulphonamides in Otitis Media

W. STIRK ADAMS

Since 1936 M & B 693 has been part of the standard treatment of all cases of acute otitis media admitted to my care in the hospital, and though the other members of the group, M & B 760, sulphamethazine and sulphadiazine have been tried, we find the most consistent results have been attained with M & B 693, though occasionally we have switched to M & B 760 with satisfactory results in a case which was responding badly to M & B 693.

I do not regard the use of sulphonamides as replacing other treatment, but regard it as of prime importance in stemming the invasion by the infection, while the local and general immune bodies are being developed in quantities required for its elimination.

The results obtained in cases of acute otitis media in the Children's Hospital, Birmingham, in the last pre-sulphonamide year, 1935, compared with those obtained in 1942, show that out of 250 admissions 63 per cent. required a cortical mastoid operation in 1935, while in 1942, out of 350 admissions only 32 per cent. required this operation.

TABLE 1  
OTITIS MEDIA, 1942

(1) Duration of Aural Symptoms Prior to Admission

(c) Duration of Initial Symptoms Prior to Admission																		
Days	1	1-5	5-7	7-10	10-14	14-21	21-28	28-35	35-42	42-49	49-56	Months					Over	Not known
Number of cases	9	61	49	25	47	34	27	6	13	3	12	2-4	4	6	6-8	8-12	20	1

(2) Duration of Aural Discharge Prior to Admission

(2) Duration of Aural Discharge Prior to Admission																	
Days												Months					
Number of cases	1	1-5	5-7	7-10	10-14	14-21	21-28	28-35	35-42	42-49	49-56	1-4	4-6	6-8	8-12	Over	Nil
	15	64	38	18	35	25	19	3	2	3	5	11	3	4	5	9	91

(3) Duration of Hospital Stay

a) Duration of Hospital Stay											Months	
Days	1-5	5-7	7-10	10-14	14-21	21-28	28-35	35-42	42-49	49-56	2-4	4-6
Number of cases	15	7	35	26	37	42	24	31	12	15	18	9

(4) Age group

	Under 1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12	13
68	45	42	27	30	40	31	18	12	12	11	8	6		
Previous otitis 14	17	7	6	5	9	7	5	3	5	3	2	3		

This is an analysis of the cases admitted with acute otitis media in 1942. From the first and second sections recording the duration of aural symptoms before admission it is clear that the majority of cases are received at too late a stage of the invasion for successful sulphonamide treatment though most of them had already received out-

media attacks of acute otitis media has not been carried



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TABLE II.

Number	Dry on M & B 693	Dry on M & B 693 and incision.	Cortical mastoid.	Transfer.	Died.	
Under 1 year	21	16	12	15	4	
1-2	13	10	10	12		
2-3	7	15	9	11		
3-4	8	8	4	6	1	
4-5	7	6	4	13		
5-6	13	9	8	9		Silver nit. 1
6-7	6	12	4	8		Furuncle 1
7-8	5	6	3	4		
8-9	5	1	3	2		Tonsillectomy 1
9-10	4	2	4	2		
10-11	1	2	3	5		
11-12	3	2	—	1		Ultraviolet light 1
						Granuloma 1
12-13	1	2	2	1	—	—
Total	94	91	66	89	5	5
Transfers	22	19	42			
	—	—	—	Without treatment		Diagnosis not confirmed
Total of cases	116	110	108	6	5	

32.1% cortical mastoids.

An analysis of the results of treatment by age-groups. The cases transferred were sent to other hospitals outside the service of the Children's Hospital (Fever Hospitals and E.M.S. Hospitals) before the conclusion of treatment for the condition. It will be noted that two-thirds of the cortical mastoids opened were so transferred. This was done because of the pressure on in-patient accommodation in the Children's Hospital.

Of the cases transferred and recorded as dry on sulphonamide, and on sulphonamide and incision of the drumhead, no follow-up has been possible, and it may prove that a few of these required a cortical mastoid operation. The number is, however, small in relation to the full figures, and is unlikely to upset the validity of the conclusions arrived at.

There was no change in the type of case admitted during these two years, nor of the severity of the prevailing infection.

## Method of Selection of Cases for Admission

The cases may be admitted either from the casualty department or on receipt of a telephone request from the patient's medical adviser; but chiefly from the out-patient department. They comprise the more serious types of infection which have proved resistant to treatment, or which may respond badly to ambulant treatment. In this out-patient department some 500 new cases were received in 1935. During successive years the number has steadily risen until now we have 1,200 new cases under treatment each year.

The 350 cases admitted in 1942 can be divided into: (1) Primary otitis media, 264 cases, 75 per cent. of the series with an operative mastoid rate of 28 per cent. This group comprises all cases where there is no history of previous otitis media. (2) Relapsing primary otitis, 39 cases, 11 per cent. of the series. This is a subdivision of the first, and shows cases where a dry ear was obtained on an initial course of sulphonamide treatment, but relapsed on withdrawal of the drug; a second course of sulphonamide was then given, in some cases with satisfactory result. (3) Recurrent otitis media, 86 cases, 25 per cent. of the series with an operative mastoid rate of 38 per cent.

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Here the operative rate is higher than in a primary otitis, and this is borne out by our experience that it is more difficult to obtain resolution of the infection by sulphonamide treatment in a mastoid previously involved than in a virgin mastoid

Although these figures show that 25 per cent of all admissions had had a previous otitis media, we should not regard this as the true incidence of recurrence, recurrent otitis media is recognized as a more resistant infection to treatment, and cases would normally be admitted to the ward. The true incidence of recurrence is probably in the region of 10 per cent and may be less

## Management of Cases

(a) Adequate nursing care is essential for at least a week after all signs and symptoms have disappeared. They are retained in hospital for a week after the end of the sulphonamide course, as it is found that relapse is most likely to occur on the fourth day after the course of sulphonamide has ended

(b) Drumhead incision where evidence of tension is present, or in the cases where spontaneous perforation has occurred without elimination of pain or pyrexia

(c) *Sulphonamide dosage*—Although estimation of the blood level of sulphonamide is advisable, an empirical dosage must be employed. It is essential to use a heavy loading dose during the first twenty four hour period, and in practice it is found that in children between 3 and 6 years old an initial dose of 2 g followed by 1 g four-hourly in the first day, dropping to 4 g on the second day, and 3 g in each succeeding day for the next four days gives the best results

The change in the dose is most easily made in the 2 a.m. feed. In infants a dose of 1 g per day for every 7 lb weight is a satisfactory working rule with sulphadiazine

## 6a AURAL DISCHARGE.

NAME \_\_\_\_\_ AGE \_\_\_\_\_ SURGEON \_\_\_\_\_

Duration of Symptoms prior to Admission \_\_\_\_\_

Date of /

Days of Stay			amt		amt		amt				amt		amt		amt	
	W	M	W	M	W	M	W	M			W	M	W	M	W	M
1																
2																
3																
4																
5																
6																

My House Surgeon, Mr A F Alvarez, has carried through a valuable investigation on the relation between the quantity of the drug given the urinary output and the blood level of sulphonamide obtained in a series of 13 cases. They fall into three groups

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In the fitter children the blood level quickly reaches its peak whilst in those children who appear more ill, and less robust, the blood level rises gently. He also finds the urinary output of sulphonamide per day varies considerably from case to case, and cannot be relied on for information of the sulphonamide blood level maintained in the patient.

In the clinical management of these cases a progress chart showing the amount of discharge from the external canal and (if opened) the mastoid wound is invaluable in assessing progress. On these charts the Charge Nurse records her estimate of the amount of discharge from each ear daily under one of four headings, Excess, Medium, Small or Dry.

One case illustrates a sulphonamide failure in a long-standing infection. Child aged 7 years, admitted with a history of apparent acute otitis on the right side. Treatment by right drumhead incision and a course of 20 g. sulphonamide failed to promote resolution and twelve days later he developed a pyrexia of  $103^{\circ}$ . A cortical mastoid operation was performed. Later we learned that he had had scarlet fever five months before, and had been sixteen weeks an in-patient at the City Fever Hospital. Towards the end of that illness his right ear had discharged for twelve days, six weeks before we received him, and at the Fever Hospital he had already had two heavy courses of sulphonamide.

Another case which illustrates the failure of sulphonamide, and the severity of the toxic reactions that may occur in infantile infections, occurred in an infant of six months. He was admitted with a history of three weeks' earache, drumhead incision prior to admission, and continuing aural discharge and earache. He had a 10 g. course of sulphonamide; although the discharge cleared, a fortnight after admission a raised temperature, rising pulse-rate and frequent stools suggested a continuing aural infection. Both drumheads were again incised and five days later a bilateral cortical mastoid operation was performed as his condition was rapidly deteriorating.

From this time on his condition slowly improved, as usual the weight being the last to recover. A journey of 40 miles by ambulance to a country hospital, and a change of nursing staff, produced a minor relapse from which, however, he soon recovered.

### CONCLUSIONS

- (1) Always use sulphonamide in the early phase of invasion.
- (2) Even when coming late under treatment up to the third week of infection there is no objection to the use of sulphonamide if no surgical contra-indications are present.
- (3) The contra-indications are, with free discharge from the middle ear :  
(a) toxic appearance ; (b) continued pyrexia ; (c) severe deafness—below 18 in. for whispered voice ; (d) any evidence of intracranial spread. All these are indications for exploration of the mastoid—which may of course be followed by sulphonamide therapy.
- (4) At whatever stage of an otitis, incision of the drumhead is essential where evidence of tension is present before sulphonamide results can be obtained.

*Misuse.*—(a) By failure to appreciate the objective ; (b) by inadequate dosage ; (c) by mistiming the application of sulphonamide ; (d) by continuing

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the application once evidence is present that the infection is not responding, (e) by continuing the use of the drug for more than ten days or exceeding 30 g in a course, (f) by asking the drug to produce results under unfavourable local or general conditions. *Local* Infection with fluid under tension, *General*: Ambulatory treatment, and where frequent recurrences of infection have occurred in the same mastoid

In using sulphonamides in adults my best results were obtained by combination of sulphonamide early and superficial X-rays later

Sulphonamide in chronic otitis is best used as a powder locally of 25 per cent. strength in boric acid powder

MR G EWART MARTIN Our departmental records indicate that ear cases are coming later to hospital for specialist advice. In many instances pain had been present for some days but having been given tablets by the doctor, the temperature and general well being appeared normal, advice was only sought because of the deafness, yet there was pus behind the drum

With what must be termed indiscriminate use of sulphonamides deafness is a much more common result of an acute ear than it was in the past

Sulphonamides are not to be disparaged in the treatment of otitis media—far from it, as they have made the otologist's work very much easier. But the benefits are being negated by faulty prescribing

Here is a brief résumé of the cases of acute otitis media, in my own department, for the five years previous to the use of sulphonamide and the five years after its use. From our records sulphonamide, in the form of prontosil, was used in my department in 1937

*Cases of Acute Suppurative Otitis Media seen in the Out patient Department of the Royal Infirmary Edinburgh with either a recently ruptured Drum or requiring Paracentesis*

## Mastoid complications

	Acute otitis media (suppurative)	following on the acute ear	Intracranial complications	Deaths
1932	198	69	5	1
1933	243	94	10	4
1934	244	73	11	3
1935	243	56	9	2
1936	266	62	4	1
1937	222	40	2	1
1938	224	33	6	2
1939	226	31	1	1
1940	203	32	2	—
1941	168	13	2	2
1942	178	26	2	1
1943	169	23	3	1

It has not been possible to include patients who went to an outside hospital instead of the Royal Infirmary Edinburgh in 1941 to 1943, which will account for the apparent drop in the number of cases of acute otitis media (suppurative)

It will be seen that in 1932 35 per cent of acute suppurative otitis media developed mastoid complications, in 1933 38 per cent, while in 1941 9 per cent and in 1942 20 per cent required mastoid interference. The percentage of intracranial complications remains about the same, if anything, a little higher or so it would appear in comparing the 10 per cent of 1933 with the 15 per cent

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of 1941. The death-rate of intracranial complications is about the same, but the use of sulphonamide has revolutionized the treatment of meningeal complications.

Last year of the 23 cases developing mastoid complications of an acute suppurative or perforative otitis media 3 developed meningitis, and it is interesting to give a synopsis of these 3 cases.

(1) Female, aged 6. Admitted to hospital on 3.8.43 with a history of having had an acute otitis media on 14.7.43, when the drum had been paracentesed. She had been given fairly large doses of sulphonamide.

On admission there was the suspicion of a Kernig's sign. Lumbar puncture was clear.

A Schwartze operation was done the following day. The temperature remained high and a lumbar puncture showed cloudy fluid with a cell count of 5,000 and Gram-negative bacilli present on culture. She was kept on sulphonamides and altogether had 198½ g. of the sulpha preparations.

4.8.43 :	Sulphanilamide L.S.F. intramuscularly	30 c.c.	=	4½ g.
5.8.43 to 9.8.43 :	M & B 693 intramuscularly	.. ..		17 g.
5.8.43 to 9.8.43 :	M & B 125 tablets	.. ..		14 g.
13.8.43 to 20.8.43 :	M & B 693 intramuscularly	.. ..		23 g.
13.8.43 to 20.8.43 :	M & B 125 tablets	.. ..		23 g.
20.8.43 to 3.9.43 :	sulphadiazine tablets	.. ..		71½ g.
3.9.43 to 11.9.43 :	sulphaguanidine tablets	.. ..		45½ g.
Total sulphonamides 198½ g.				

Patient was also given pentnucleotide injections intramuscularly, 56 c.c.

Recovery was complete. Patient was in hospital for seven weeks, and when seen one month ago the ear was dry and healthy. The only difficulty was that she had a slight drop foot on the right side, possibly secondary to the intramuscular injections.

(2) Female, aged 33. Admitted on 28.12.42 with a definite mastoid infection following an acute otitis media which she developed ten days previously. She had had sulphonamide—about 2 tablets of M & B 693 each day before admission. There was no description of the ear.

On admission there was a posterior perforation. Swelling over the mastoid, slight neck retraction and a Kernig's sign was present. C.S.F. was turbid with a cell count of 2,000. The right mastoid was opened. There was a large pool of "laked" pus in the mastoid which was drained.

Patient was put on large doses of sulphonamide.

28.12.42 to 31.12.42 :	M & B 125 tablets	.. ..		16 g.
28.12.42 to 8. 1.43 :	M & B 693 intramuscularly	.. ..		31 g.
8. 1.43 to 11. 1.43 :	M & B 125 tablets	.. ..		13 g.
11. 1.43 to 12. 1.43 :	Sulphadiazine tablets	.. ..		7 g.
12. 1.43 to 16. 1.43 :	M & B 693 intramuscularly	.. ..		23 g.
12. 1.43 to 14. 1.43 :	M & B 125 tablets	.. ..		10 g.
14. 1.43 to 19. 1.43 :	135 hypiloid sulphonamide	.. ..		31 g.
19. 1.43 to 23. 1.43 :	M & B 125 tablets	.. ..		12½ g.
Total sulphonamides = 143½ g.				

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There was a growth of hæmolytic streptococci from the mastoid and Gram-negative bacilli reported from the C.S.F. These were seen in further specimens, with a great number of pus cells.

Recovery was complete with a healthy ear and a hearing of a whisper at 8 ft. The patient has been back at work since the middle of May, 1943.

(3) Male, aged 12. Admitted on 22.11.43 with a history of pain in the ear for three days.

On admission patient was restless. There was neck rigidity and Kernig's sign.

The right drum was incised and the organisms showed a pneumococcus. Lumbar puncture showed a cell count of 15,000 and a type 8 pneumococcus.

The patient was given sulphanimide intramuscularly and sulphapyridine by the mouth every four hours for five days. The temperature came down in three days to normal but there was a relapse. He was transferred to the neurological department and there the sulphonamide was continued by drip along with anti-pneumococcal serum. He showed little response and died on 9.12.43.

The percentage of complications in otitis media, first mastoid, second intracranial, and third general, is still too high. Deafness as an after-complication is on the up-grade.

I am far from convinced that sulphonamides given in the commencing stages of acute otitis media (non-perforated) have any value on the course of the infection. The sulphonamides also can have little action where there is erosion of bone.

It may be that with further work on the penicillin group our ideas on the treatment will be revolutionized, but, at present, there is no rule of thumb treatment with the sulphonamide group in an otitis media such as there is in cerebrospinal meningitis.

My own plan is to give sulphapyridine (M & B 693) if necessary only after the paracentesis has been done—not before—and in fairly large doses. M & B 693 has a stronger action on the pneumococcus though it is more toxic to the patient. This can be continued until the organisms are isolated when the treatment can be changed.

It must be impressed on the student or the general practitioner that if sulphonamide is given in an acute otitis media the ear requires more careful watching than if the drug were not given at all.

MR. F. W. WATKYN-THOMAS said that sulphonamides would act in tissue fluids so long as there was an invasion of the blood-stream, of the lymphatic stream, or of the cerebrospinal system. He did not believe that they would act effectively in bone, or that they could act at all in an abscess when the vessels leading to it were thrombosed. Nor did he think they were effective against pus. For this reason the operative word in Mr. Stirk Adams' paper was the "invasive stage".

He was not altogether in agreement with Mr. Martin about not giving sulphonamides before a paracentesis. He felt that the useful time to give the sulphonamides was, if possible, within the first hour or two of the invasion, and then to give them in a loading dose. Once one did a paracentesis one had pus, and there he would stop the sulphonamides and wait and see what happened.

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Some years ago he was an early operator, but now with the sulphonamides they had that confidence which enabled them to await events. If the patient did get meningitis, which was unlikely, a first-rate weapon was available as an aid to surgery. They were fortified in their resolution to wait for a week or a fortnight, and, even without sulphonamides, a great many of these cases did clear up.

Although the number of mastoid cases had certainly fallen it was his impression, although no more than an impression, that the number of intracranial complications had not fallen during the last few years. The mortality of meningitis had enormously improved, but the actual incidence of meningitis had not diminished.

The question of petrositis: When there was any indication of petrosal invasion he was most strongly opposed to giving sulphonamide, which could not affect the process, but could mask the signs, and this was very dangerous. He preferred to keep sulphonamides in reserve and not use them unless he had definite evidence of meningeal or vascular invasion.

MR. L. GRAHAM BROWN desired to stress first the delay in resolution in cases of acute otitis media in which sulphonamides had been given. He would cite one case. A clergyman had an attack and was treated with sulphonamides. The acute condition subsided and the tympanic membrane healed. Seen for the first time by him it was noticed that the drumhead was of a greyish-pink colour, indicating incomplete resolution. Being in a quandary as to what to do, he kept him under observation for a while and then came to the conclusion that it was necessary to incise the drumhead, which he did. That healed again quite readily, but the same appearance persisted for three or four months before the patient regained normal hearing. This case illustrated the delay in resolution which might occur in using sulphonamides. Secondly sulphonamides undoubtedly masked the symptoms and might lull one into a sense of false security. He attended certain municipal hospitals where, after the use of sulphonamides, complications were occasionally seen. One case was that of a girl, aged about 18, who was admitted to hospital with acute otitis. She was treated for a month with sulphonamides in the ordinary way and then discharged. She turned up at the out-patients' department—this was the first time he had seen her—and he diagnosed a mastoiditis and operated at once. Although the lateral sinus was on the point of becoming infected complete recovery ensued.

Another case was not so fortunate. This patient was admitted to hospital and put on treatment with sulphonamides. He did not see the case for a week after admission, and then noticed that the patient complained very little, the temperature was normal, the pulse-rate was normal, and the only symptom was a little deafness with discharge. The appearance of the drumhead did not then suggest a mastoiditis. A week later when he next saw the patient he came to the conclusion at once that mastoidectomy was necessary. He operated and found pus in great quantity in the mastoid. The wound healed completely and the patient left hospital apparently cured. About ten days later he received a telephone message from another hospital to the effect that the same patient had been admitted with signs of meningitis. He died and at autopsy a cerebral abscess was found.

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He agreed that sulphonamides were of use in the early stages of infection, but he thought that was their only use apart from their recognized value in intracranial complications. After infection got into the bone no sulphonamides would cure it.

LIEUT.-COLONEL NORTON CANFIELD, U.S.A.M.C., said that the present paper was very timely. Mr. Stirk Adams had followed his cases through very well. Under circumstances of extremely close clinical observation there could be no doubt that the use of the sulphonamides was very valuable in some cases, but he wished to express agreement with those who had already spoken concerning the difficulties arising from the use of the drug. From their own experience with military personnel they were rapidly coming to the conclusion that the drug was causing more trouble among the troops than it did good. He said that because of the manner in which it had to be used. Military personnel were under much less satisfactory observation in many cases while the drug was being used than were ordinary civilian patients in hospital. These military patients went back to duty and then they had a flare-up of infection. He still thought that in the first few days of infection the drug could be used, but it should be used no longer than one week unless severe complications ensued.

THE PRESIDENT said that one point which had not been mentioned was the connexion between the sulphonamides and agranulocytosis. A large number of papers had been published blaming the sulphonamides for these developments. He wrote to the medical department of Messrs. May & Baker, the producers of the drug, and in their reply they said that they were satisfied on the point that sulphonamides could produce agranulocytosis and had done so. Several papers had been published on this point and certain very striking cases were described in the *American Journal of Medical Science* for June 1942, and two other cases in December, 1943, which were quoted in *The Practitioner*. These latter patients were cadets aged 22 and 26. Both were critically ill and not expected to recover when sulphadiazine was administered. Most people under these circumstances would have concluded that the sulphadiazine was a factor in the production of the ensuing agranulocytosis, but the surgeon in control of the cases reinstated the sulphadiazine treatment, got the blood level up, and both cases recovered completely under big doses of the compound.

Therefore it did not seem to be proved that the agranulocytosis was due to the sulphonamides. He himself was perfectly convinced, having had one or two cases, that a high septic infection was just as likely to be a factor in the production of agranulocytosis as the sulphonamides. He had a case last year in a child aged 2 with streptococcal infection of the throat. Sulphadiazine was given, the total dose being 2.25 g., a very minute dose. The patient was sent into hospital under the care of one of the physicians. Other treatment for agranulocytosis was carried out, including liver extracts, blood transfusion, pentnucleotide, etc., but the child got worse. He suggested that the child should be put on large doses of sulphathiazole but the physician in charge would not agree with that suggestion and the child eventually died. He thought, that in this case, the conclusion that the agranulocytosis was due to a minimal dose of sulphonamides was quite unfounded. In his opinion the agranulocytosis was a direct result of the extreme septic intoxication. He believed that had it



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been possible for the child to have been adequately treated with sulphonamides it might have had a fair chance of recovery.

WING COMMANDER G. H. BATEMAN gave the Section some statistics concerning the treatment of otitis media in Service hospitals. The cases were all primary ones ; recurrent cases had been excluded. During 1942-43 there were 705 cases in this group of which 333 were treated with sulphonamides, and 372 without. Among the cases treated with sulphonamides 49, or 14·7 per cent., required mastoid treatment, and in the cases treated without sulphonamides, 35, or 9·5 per cent., required such treatment. These figures might or might not be significant. In the cases treated with sulphonamides the average time from the appearance of the first symptom to the giving of the sulphonamide was 3·4 days and the average time from the first symptom to operation was twenty days. In the cases which did not have sulphonamide the average time from the first symptom to operation was seventeen days. Thus they were very similar groups of cases.

MR. I. S. HALL said that in Edinburgh during the three years prior to the use of sulphonamides there was an equal number of cases with the same complications as during the last three years—about 32 in each period ; this for a hospital population of just over 10,000. These figures went to prove that there was no reduction by the use of sulphonamides in the incidence of complications. But there was possibly an explanation of that circumstance, and if the careful work that Mr. Stirk Adams had told them about was extended they could fairly expect a reduction in the incidence of complications, because the majority of such complications were in recurrent or chronic cases. If the incidence of otitis media and its more serious manifestation of mastoiditis could be reduced in any way, the incidence of complications might eventually be reduced also. From his figures it was shown that whereas the mortality was high among the pre-sulphonamide group, the mortality had been reduced to a quarter after sulphonamides came into use. The important point was that in sulphonamides we had a most potent weapon against the complications of otitis media.

MR. R. D. OWEN said that Mr. Ewart Martin was very fortunate indeed to have had so many cases of acute otitis media with so few complications. His ability to get the cases early and to retain them in hospital under observation from the beginning proved how valuable it was from the very few cases in his series that went on to mastoid retention.

This not only proved the value of early and efficient use of sulphonamides but also that the same consistent result could be obtained by early treatment. This in his opinion was a strong reason why acute otitis media should be made a notifiable disease. It was the only way to prevent the chronic form.

He asked Mr. Stirk Adams whether he advised the use of the Politzer bag during the recovery period following acute otitis media as a measure to prevent the retention of effusion in the tympanum.

MAJOR G. C. LARGE, R.C.A.M.C., said that during four years of ear, nose, and throat work in the Canadian Army he had yet to do a mastoidectomy. He thought that the main reason was that the cases were received very early, in fact within a few hours. Whether the regimental medical officer had become "ear conscious" he did not know. During the past three months he had been

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able to work wholly with the British Army, in that time he had seen some 300 ear cases, and had had to do 15 cortical mastoid operations. The cases had been seen an average of five days after onset. The great importance in the use of sulphonamides was the very early treatment with these compounds and in large doses, along with the usual treatment of paracentesis, cleaning and drops.

MR R L FLETT said, with regard to early treatment with sulphonamides, that in a number of these cases of acute otitis media, if one got them within six hours, quite often paracentesis was not required. The drug was then, he thought, definitely of value.

In children under 2 he found this a very treacherous drug to use. He had had three cases in which children between fifteen months and two years of age had been sent into hospital, two of them with a diagnosis of bilateral mastoiditis and one with bilateral otitis media. All were put on sulphonamides, improved and sent home. They were first brought to him about four months later when all three children were totally deaf. He decided to do a mastoid operation on all of them, and the mastoids were found occupied by granulations of a rather pale colour. There was some pus, rather thickish in nature. The mastoids and drums healed up. All these children were now in a deaf and dumb institution. At the early age at which these children had been sent into hospital one could not tell that they had lost their hearing.

MAJOR J I MUNRO BLACK, R A M C, said that he had been in a hospital where he had seen his acute otitis cases within a matter of hours. Even three days was too late. On seeing cases within a matter of hours, he was amazed at the satisfactory results with routine treatment using sulphathiazole. He did not extend that treatment for more than two or three days with 15 to 20 g. If at the end of that time they were not doing well he stopped everything. He added that the civilian consultant only saw the patient where the general practitioner failed.

MR F C ORMEROD said that apart from the treatment of complications, the first few hours in the disease were the only time when the sulphonamides were of use. Brigadier Whitby had postulated that the sulphonamides must be given early and in heavy doses, and that they were of no value in the treatment of a bony cavity containing pus.

Figures had been given by Mr Stirk Adams and Mr Ewart Martin showing how mastoid operations performed about 1935 compared with 1941-43, but the years up to and including the winter of 1934-35 had severe epidemics of influenza, with a considerable amount of acute otitis media and mastoiditis. In recent years there had been very little influenza, but there had been a severe epidemic in 1943-44. He had had more cases of otitis media and mastoiditis during the past winter than for many years past, and it would be interesting to have Mr Stirk Adams' and Mr Ewart Martin's tables continued in order to include the past few months.

MAJOR G A HENRY, R C A M C, said that in the winter of 1942-43 in a large camp serving 30,000 to 40,000 men there were some 260 cases of acute otitis media. It was the policy to hospitalize these men at the first sign of an acute middle-ear infection. Sulphathiazole was given in adequate dosage immediately if the drum had not ruptured or paracentesis was not urgently

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required. If a purulent discharge were already present on admission, unless the patient had a high fever or seemed ill, sulphathiazole was not usually given. Local ear treatment and nasal shrinkage by ephedrine spray was routinely carried out. Among this group only five went on to mastoidectomy. Two of these required extensive operative treatment because of a meningitis which occurred early in the course of the ear infection but fortunately recovered. All cases were hospitalized until the ear had been dry for a few days. He had not noticed that there was much loss of hearing on discharge and only in 1 or 2 per cent. of cases was the man sent out with a perforation of the drum.

MAJOR E. P. FOWLER, U.S.A.M.C., said that the two openers had spoken about the effect of sulphonamides in the early stages, and Mr. Stirrk Adams had given statistics concerning fairly severe cases of otitis media—the two were not comparable. It was extremely important to know what organism was involved, and also to keep in mind the fact that a large number of these cases got well without any sulphonamides at all.

No speaker had mentioned very seriously the question of the development of chronic ear trouble. He was under the impression that in the American Army a certain amount of recurrent ear trouble and eventually chronic ear trouble and permanent deafness were caused by inadequate and promiscuous use of sulphonamides. The sulphonamides were given early by almost all the medical officers, but they were often not given in the right dose and over a long enough period. His own rule of thumb method was to continue until the hearing improved. Sulphadiazine was used in the American Army and it was possible to give it for weeks or even months. The other drugs, sulphapyridine and sulphathiazole, could not be given for such a long period, and they were more likely to cause reactions, especially sulphathiazole. The sensitivity of the individual to the drug must be considered. With some people the drug worked very well, and with others not at all. He had been interested to hear Mr. Ormerod call attention to the increase in mastoiditis this year, because in the American Army they had had the same experience in spite of the almost universal treatment of all acute otitis with sulphonamides.

On the general question he would only say that judgment must be based on the individual case. If the sulphonamides worked, they should be continued for a long time; if they did not cause dramatic improvement at an early stage a mastoidectomy should not be too long delayed. Certainly no drug yet developed permitted one to discard or delay myringotomy as is believed by many general practitioners and paediatricians.

MR. STIRK ADAMS, in reply, stated that he regarded the failure of recovery of hearing in the effected ear as evidence of an unresolved infection and usually an indication for mastoid exploration. Politzerization might be used where incomplete recovery of hearing had taken place, but not in the immediate post-inflammatory period. He stressed the great care required in accepting a recovery as established, and in refusing to allow a patient release from supervision in the phase of apparent recovery, before this recovery had been tested by gradual restoration of physical activity.

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## THE ASCERTAINMENT OF DEAFNESS IN INFANCY AND EARLY CHILDHOOD

By I R EWING and A W G EWING

From the Department of Education of the Deaf University of Manchester

THERE is an urgent need to study further and more critically methods of testing hearing in young children. During the first year of life the deaf baby's voice has natural quality and inflections. Gramophone recordings of the vocalization of deaf infants up to age one year are indistinguishable from similar recordings of infants whose hearing is unimpaired. But even during this first year the existence of deafness needs to be ascertained. Experiment has shown that skilled training can do much to conserve normal voice habits, once the need for it is known. It has also proved possible to begin to develop in children of two years and under the capacity to comprehend speech through lip reading, or better still, where partial hearing exists, through hearing combined with lip reading. We would urge that both these forms of training should be initiated while the deaf baby is most dependent and in closest physical contact with mother or nurse. If he is not given special training there is considerable risk that when he begins to walk freely he will become increasingly, almost even exclusively preoccupied with exploration of the world of things. In such cases interest in persons, which is an essential foundation to the acquisition of lip reading and the development of speech through it, is often found to be lacking. A gap begins to open in vital social relationships. This coupled with the fact that deafness deprives the baby of all those stimuli to thought and the mental training normally associated with learning to talk, greatly adds to his own and to his teacher's difficulties if educational treatment is deferred until he is older.

Both in Britain and in the USA more accommodation (but not nearly enough) is beginning to be given in schools for the deaf to children

of three years and over. In this country admission at five years was made compulsory in 1937 and by the Education Act of 1944 an obligation is laid on local authorities to admit deaf children to special schools at two years if the parents desire it. Our own investigations had brought further evidence that training needs to be begun at the earliest age that the diagnosis of deafness can be established. This evidence combines with logic to show that congenital deafness and deafness acquired in early childhood must not be allowed to break the continuity of speech development that has already started in the form of spontaneous vocalization.

Reliable methods of testing young children's response to sound are needed also in the diagnosis of congenital aphasia and of other forms of defect that call for speech therapy. Many children suffering from dumbness or disabling defects of speech are being referred to our clinic. It is not by any means always possible to tell from a child's speech alone whether his trouble is due to deafness.

The main trends of the present investigations were determined by a series of somewhat startling observations that seemed at first anomalous. Within a few weeks three instances occurred of complete absence of response, reflex or learned, to loud sound, followed later by unmistakable evidence in each case of some capacity to fulfil instructions spoken in an *mf* voice from a distance of 6 feet. One of the children was dumb, the others had marked defects of speech. This experience suggested that the whole basis of the tests might have to be freshly interpreted. This was a plain indication that factors other than the purely physical characteristics of sound, its pitch, loudness and duration, might determine the young child's response or failure to respond, irrespective of any adult efforts to secure his attention.

The records and conclusions of Gesell, Buehler and Hetzer, Lewis and Valentine, as well as of earlier investigators of normal child psychology, like the Sterns, confirmed the need of a developmental approach. A synthesis of their findings seemed inadequate for our own purpose but it emphasized experience of the human voice as the most outstanding and persistent factor in the normal child's aural environment. Within a few weeks of birth he becomes capable of reacting discriminatively to soothing or angry variations in its tones. Gradually, but in the later part of his first year, the increasing complexity of his cerebral processes becomes associated with capacity to perceive discrete words and phrases and to apprehend something of their meaning. No other forms of sound demand from him such efforts of attention, such intricate analysis and synthesis, so much remembering.

We felt that fuller knowledge was needed about the response to sound of infants and young children whom we might expect to find in possession of normal hearing. It seemed unwise to abandon all tests other than

# Deafness in Infancy and Early Childhood

voice tests Drums, bells and pitchpipes give loud sound that is very useful for proving residual capacity to hear in young children whose acuity is impaired We wished to study all the variations in response that we might encounter, whether in the frequency of their occurrence or in its quality With the kind permission of Doctor J L Burn, Medical Officer of Health we gave our tests of hearing to children attending War Nurseries in the City of Salford and to babies in the care of Maternity and Child Welfare Centres whose mothers willingly brought them for test

## Part 1.

### TESTS OF THE HEARING OF CHILDREN AT SALFORD WAR NURSERIES

#### The Tests

Three groups of tests were used —(a) Voice and speech tests, (b) percussion toys including bell, drum, triangle, etc., (c) a range of pitchpipes from 120 cycles to 1,900 cycles, (d) "meaningful sounds", e.g. chink of feeding bottle, knock at the door, light tapping, crackling or rustling of paper

It was realized early that it would be useless to attempt to standardize the tests or to time them because the interests and behaviour of such young children are both variable and individual Our aim was to find out three things —

- (i) To what kind of sounds ordinary children pay most attention
- (ii) How they respond to sounds which interest them
- (iii) What kind of sounds they appear to ignore

The ages of the children to be tested ranged from one month to four years eleven months The order of the tests and the procedure followed were therefore adapted throughout to the child's age and were changed or modified according to his response

At first all children were tested individually Later it was found that when two came together and were encouraged to play with toys on the floor, they settled down much more happily and naturally than when one child came alone It was not difficult to note the response of children separately because there were always present the matron, the writers and at least one other observer Individual tests, however, were made with all children in arms Voice tests with infants under six months and speech tests with children over that age were always made first to stimulate as far as possible co-operative activity

The tests were made from a distance of about six feet and without the child watching One of us, helped by another worker, concentrated on observing each child's behaviour and response. The other offered the stimuli and recorded the results

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The distribution by age and sex of the children was as follows :—

TABLE I.  
CHILDREN TESTED AT SALFORD WAR NURSERIES

Age (years)	Boys	Girls	Total
0·0 to 0·11	11	11	22
1·0 to 1·11	14	9	23
2·0 to 2·11	11	9	20
3·0 to 3·11	11	10	21
4·0 to 4·11	1	4	5
Totals	48	43	91

## Results of Tests

### *Ages 0 years to 0·6 years*

Every child tested showed by his response to all or to some of the tests that he could hear. In spite of many variations in behaviour definite trends and tendencies appeared which were of considerable interest in themselves and also of value in the determination of total or partial deafness in infants. During the first, second and third months percussion sounds yielded quicker response than voice. As a rule in the first place the manner of a baby's response was reflex and took the form of blinking, screwing up of the eyes, involuntary jumping, twitching of fingers, turning (even in sleep) towards his nurse. Some children responded unflinchingly in the same way every time a stimulus was repeated, others appeared to ignore a sound after two or more repetitions. Others changed from a reflex to a learned response, e.g. at first jumping at the clang of a bell and when the sound was repeated turning in what appeared to be an imperfect attempt to locate the sound. Even at two months two definite tendencies were noted—that a quiet voice was more effective than a loud voice and that voice encouraged a learned response more readily than percussion sounds or the pitchpipes. For example at the sound of voices instead of jumping or twitching there might be a change of expression in the baby's face ; even a smile or a look of contentment. This was, of course, what might be expected because the sound of voice was becoming increasingly meaningful and would be associated with many routine acts such as feeding, washing and comforting. During the third, fourth and fifth months voice steadily gained over percussion sounds as a form of stimulation in winning quick response. The sound of voice or speech promoted action more and more frequently, as for instance when a baby of four or five months held up his arms at the word "come", or when he himself vocalized at the sound of a cooing or lilted voice. A tendency was shown and increased with age for a child to meet percussion sounds with learned rather than with reflex response. He might still jump and twitch at the loud beat of a drum or the clang of the bell but he would also turn towards it or show dislike of it by facial

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expression To all these tendencies there were of course some exceptions One child of two months responded more definitely and quickly to voice than to percussion sounds and another baby of the same age, who did not respond to any sound of voice or to percussion noises, turned immediately at the chink of two feeding bottles and began to whimper and to purse his lips ready to take food Afterwards he turned for the sound of voice and of the bell and drum, also, he appeared to ignore all sounds until one was offered that held meaning for him at that moment

### *Ages 0·7 years to 0·11 years*

During the second half of the first year response to the tests changed considerably

Capacity to locate the source of sound correctly was noted in nine of the eleven children in this group Our criterion was that the baby should turn head and eyes in the direction of a source of sound made outside his immediate field of vision either behind his back or to his right or left Skill of this kind was rare before the age of six months By eleven months turning of the head and eyes tended to occur more frequently and more quickly than any other reaction The records at this age include the comments "Turned, sharply localizing", and "Localized instantly" So far as our opportunities of observation have permitted we would say that capacity to locate the source of sound within an infant's immediate environment, at distances up to ten or twelve feet, can first be observed at two to three months, tends to be imperfect between that age and eight or nine months, but is highly developed in the average child by the end of the first year

Attempts to locate sound before the age of six months were often slow Like the reflex, they were more easily evoked by loud impulsive sound (the bell) They might take place only after the stimulus had been repeated several times Reflexes were still found in most of the children aged six to eleven months, but tended to be much less easily evoked and less varied in character than at an earlier age Sometimes the same stimulus first excited a reflex then the learned response of turning head and eyes to locate the source of sound We recorded "Bell, blinked and slowly located" and "Bell, jumped and located instantly", etc. It will be noted that both the instances just quoted are of response to the large bell After the age of six months the drum had become a less effective aural stimulus It seemed that during this period of their lives the babies were learning rapidly to discriminate between sounds They showed increasing capacity to distinguish sounds of different physical patterns The word "pattern" is used deliberately here Pure-tone stimuli were tried but proved much less effective than the complex sounds already described At this age a baby's response to an aural stimulus may be determined by its degree of likeness or unlikeness



to forms of sound previously encountered as well as readiness at the moment to take an interest in it. He is obviously incapable as yet of learning to attend consciously to test sounds. In many cases we noted response to sound of loudness considerably less than that of conversational speech at six feet; e.g. very light tapping on the table, a small wooden cylinder rolling on the floor. Skill in discriminating sound of relatively like "patterns" was considerable. We found that the children distinguished different voices. As might be expected they often responded most readily to the voices of mother, nurse or matron. Changes in the tone of voice used by a single speaker affected them. A quiet tone was as a rule more likely to attract attention than a loud voice.

Other investigators have observed that babies from six to twelve months begin to recognize a few words and phrases that are said to them. The extent of this understood vocabulary seemed too small, however, to offer a basis for word or sentence tests of the type that we have found invaluable with older children.

There was no doubt that for all the children of this age voice tended to carry a high degree of meaning. It has been mentioned that they were found to pay most attention to voices when they were quiet. They showed similar discrimination in favour of quiet noises, of the kind that indicate human approach or activity near at hand. A child would be roused instantly by the smallest click of the door handle when turned from without, or by the quietest rustling or tapping. Yet immediately before or after this he might show complete indifference to much louder sound, made by the pitchpipes or the drum. Sufficient repetitions of a percussion sound, however, usually elicited a learned response. Every child reacted to at least one of the pitchpipes. Even with these very young children there were many individual variations in response as well as variations in the reaction of a single child during the period of testing, but every child could be proved to hear several stimuli and these usually included some sounds about 40 to 50 phons in loudness (the equivalent of an *mf* voice).

### Conclusions

- i. During the second half of the first year of life reflexes give way to learned responses.
- ii. Capacity to locate the source of sound by turning the head or eyes has become well developed and can be evoked by suitable stimulation.
- iii. Skill in distinguishing different complex sounds, e.g. the click of the door handle, is considerable by the end of this period.
- iv. The voice has meaning for all infants at this age and gains their attention quickly if suitable tones are used.

# Deafness in Infancy and Early Childhood

## *Ages 1.0 to 1.11 years*

The second year of life brings further developments in response to aural stimuli. These offer scope for somewhat more precise investigation of hearing, but they also demand very careful study of each child's character, attainments and emotional attitudes during the tests.

Most important during this period is development of capacity to comprehend a few words and simple phrases in certain situations that are familiar to the child. Nevertheless we found much variation in individual capacity to understand any words. At 1.2 years a child would put down a toy or wave his hand when told to say "Good-bye", and by 1.6 years some children would fulfil correctly some simple commands, "Give one to matron", "Put it on the floor", "Come to dinner", yet no response to many such phrases was made by one child aged 1.8 years, whom the matron reported to be backward in all behaviour and who proved inactive, uninterested in the usual toys and to be lacking in alertness. Another child of the same age failed to carry out simple instructions. Her health record was "General condition satisfactory. Small and under weight on admission. Recent attack of whooping cough". The matron reported that her habit was to creep about very quietly and that she had never been heard to make any sound. This girl, however, turned her head and eyes to locate light tapping and the rustling of paper.

We concluded that very simple speech tests of hearing are suitable for most children over 1.6 years, and for a few younger ones. Capacity to hear *pp* speech at a distance of 6 to 9 feet could be proved in most of these cases. Whispered speech as yet attracted little or no interest. At each of the ages 1.5 years, 1.7 years and 1.9 years there was one child who made approximate attempts to repeat a few words said to him by the matron or nurse, ermmum (mummy), airpor' (airport), digor and dizer (engine). This did not of course represent the whole of the capacity to talk of this group of children, only the maximum amount of evidence obtainable by us in the limited time and conditions of a test of clinical type.

The second change in behaviour observed in children from 1.0 years to 1.11 years was a marked increase in the influence of children's personalities upon their response to sound. Degree of alertness in response tended to correlate with the stage and standard of each child's motor behaviour, as evidenced by his capacity to walk, to imitate the placing of one brick upon another and to insert small cylinders into sockets. One child, however, although not walking at 1.6 years, carried out several simple commands correctly. Emotional attitude (no doubt temperament too) was a strong determining factor. As a rule there was some degree of co-operation from the children when they had reached the age of 1.6 years, but this had to be won with care. As has already

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been mentioned, we found that the presence of another child was frequently a short-cut to the establishment of confidence and willingness to co-operate. With all children of this age-range, who were not deaf, the best means of approach was to talk quietly, simply and directly to them about something in which they had shown interest.

Most of the children, while at play turned or looked up or appeared more alert if called by name. It was possible thus to prove that a child could hear a *pp* voice from a distance of 6 feet or more even when we could not be sure that he had comprehended directions spoken equally quietly. The meaningful sounds were also effective in eliciting a response to weak sound. There was a tendency, even more marked than amongst the babies under 0·11 years for any or all of the percussion sounds to be ignored. One boy, who ignored the loud bell looked up when the door was rattled by the wind. Another boy, unaffected by three rings of the bell, turned immediately at the crackling of paper. Later, he responded to the bell, which when repeatedly rung, usually brought about a learned response. It was clear that these children were approaching a stage when they might ignore completely a considerable amount of noise, even when it occurred in their immediate environment.

Nearly all the children responded to one or more of the pitchpipes, but not always to the first to be used and sometimes only by looking up. The voice and meaningful sounds were more effective in gaining evidence of the children's skill in locating sound. All except three showed that they possessed this skill in a high degree and could turn promptly in the right direction.

The use of pitchpipes to explore the range of frequency over which children could hear was still impracticable up to the age of 1·11 years, within the conditions of our tests, although we recognise that observations on a number of occasions might lead to definite findings, provided that a child did not learn to ignore this form of sound.

### Conclusions

i. Simple speech tests of hearing are suitable for most of the children over 1·6 years and for a few intelligent younger ones.

ii. Children of this age do not pay attention to whispered speech, it is therefore unsuitable for use in tests.

iii. Quiet speech wins the interest and attention of the children more quickly and effectively than loud speech.

iv. A tendency to ignore loud percussion sounds and other loud noises is shown to increase with the age.

v. Pitchpipes though useful are not as yet an accurate means of measuring the range of frequency over which a child of this age-group can hear.

# Deafness in Infancy and Early Childhood

*Ages 2.0 years to 2.11 years*

Amongst the children of this age-range we found two important developments that affect tests of hearing. First, that the child's achievement of freedom to move easily from place to place by walking or running, was accompanied by a great increase in verbal comprehension. There were still exceptions. We failed altogether to obtain evidence of this capacity in two children of 2.2 years.

The complexity and variety of spoken directions, suggestions or questions to which the children would make a response indicative of comprehension had grown considerably by the age of 2.4 years. "Go with Jimmy back to the nursery" for instance, calls for understanding of two prepositional relations in the one sentence. "Go and bring Sandra", refers to a person not present at the time of speaking and persistence in a more prolonged series of actions than the simple "Give it to matron".

Secondly, nearly all the children over 2.6 years were talking spontaneously and could be engaged in a very simple kind of conversation by the matron or nurse or by us although strangers. However, one girl 2.7 years was reported to have very little speech. A boy of 2.9 years was believed to have only begun to talk after admission to the nursery in the previous month. In this case every form of reaction was slow and there was little spontaneous motor activity of any kind.

The need of a variety of aural stimuli sufficient to meet many individual differences in the habits, interests and attitudes of the children, was still greater than for the younger children. Three of the twenty children aged 2.0 to 2.11 years ignored the drum, bell and crackling of paper, but all responded to one or more of the pitchpipes. The meaningful sounds were still very useful although not always effective. Capacity to locate sound was good. Reflexes were seldom observed and then only as the result of very loud stimuli.

In a number of cases it could be proved that the child heard sound throughout the whole range of frequency represented by the pitchpipes and at the intensity of a *pp* voice.

All the children gave unmistakable evidence of hearing several different stimuli and none failed to react in some definite way to at least one of the workers present, speaking in an *mf* voice from a distance of 6 feet or more.

## Conclusions

- i. Speech and voice tests now proved to be a satisfactory means of testing hearing.
- ii. Variety of meaningful stimuli were necessary to meet the interests of children in this age group.

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- iii. Pitchpipes now proved to be a suitable means of testing a child's response to a range of frequencies.
- iv. Capacity to locate sound was good.
- v. Reflexes were rare.

*Age 3·0 years to 4·11 years.*

For the children whose ages came within these two final years of the pre-school period the sound of speech and of the voice proved to be much the most effective form of stimulus. None of these 27 children failed to fulfil directions or to answer questions spoken in an *mf* voice and all showed understanding of a considerable vocabulary. Many responded suitably and promptly to the first words addressed to them. There was a tendency for other sounds, especially those of little social significance to evoke much less response. The noise of the door being opened from outside still caused many children to look towards it, or at least to look up. Other meaningful and percussion sounds, such as loud knocking, light tapping, the bell and the drum were no longer so effective. Nevertheless the stimuli previously used were successful with some or other of the children.

The tendency first noted in babies aged 1·0 years to 1·11 years, to be more interested in quiet than in loud sound, was again very noticeable. A girl, for instance, who had ignored the large bell rung suddenly behind her back at a distance of a few feet, responded to the more distant sound of an electric bell outside in the passage, although she was hearing it through a closed door. There were several similar instances.

Five children, whose ages ranged from 3·1 years to 3·11 years and four 4·0 years to 4·11 years old, who had responded very well to speech, fulfilled directions whispered from a distance of at least 6 feet. It is possible that this test might have succeeded in other cases if more time could have been spared to give it.

This evidence that sound of such weak intensity as a whisper (about 30 phons) could elicit response, led us to attempt measurement in a number of cases by pure-tone audiometer. The trend of the results was unmistakable. We could train the more co-operative of the children with good intelligence to signal when they heard a pure-tone stimulus, but reliable response, verifiable by repetition, could not be obtained, to sound of intensities approaching the threshold of audibility for older children and adults. Whatever their pitch, pure-tones had to be given an intensity greater than that of a whisper to be effective.

### Conclusions

- i. Speech and voice are the two most effective forms of stimuli in tests with children of this age.
- ii. Quiet speech wins quicker and more interested response than loud speech.

# Deafness in Infancy and Early Childhood

iii. Whispered speech is now a suitable means of testing hearing.

iv. Pure-tone audiometric tests are unsuitable for these children because:—(a) they cannot maintain interest in listening to pure tones for long. (b) reliable threshold readings cannot be obtained before the child's interest and attention flag.

## Part II.

### Tests of the Hearing of Pre-School Children Suspected of Deafness

Opportunities of testing the hearing of infants under twelve months are comparatively few. Impaired hearing is not looked for in infancy unless for some special reason, such as the existence of congenital atresia, or because parents are made anxious because there is a family history of deafness.

Before summarizing the results of our tests of children in this group we shall describe individually four typical cases to illustrate the value and significance to the child's future mental and social welfare of the findings of the tests.

A.B. was born of deaf mute parents well known to us. We were asked to give our opinion about the baby's capacity or incapacity to hear. One of us first saw the child 24 hours after birth and again when he was a week old and at frequent intervals thereafter. From four weeks onward all the evidence we obtained from tests indicated that the baby could hear. The problem therefore became one of speech development not of deafness. How could an only child learn to talk when his parent's main means of communication were finger spelling and signs?

In another case it was the mother herself who suggested that she should ask her neighbours and relatives to talk naturally and constantly to her baby. Incidentally that child is now a scholarship pupil at a well-known Public School for Girls.

C.D. was the illegitimate child of a congenitally deaf woman who had been educated orally. Tests over a considerable period proved that the baby was severely, if not totally, deaf. Steps were immediately taken to encourage her to watch people's faces and thus to make an early beginning in lip-reading. At 2·3 years she was sent to a school for the deaf where she was taught to lip-read and speak to a standard far beyond that which her mother had achieved.

E.F. with bilateral congenital atresia. There was no history of deafness in the family. The doctor and the mother concerned feared that the child was deaf. At her first visit, when she was four weeks old, the baby jumped at the clang of a bell, the beat of a drum at 3 feet and at the sound of pitchpipes from 120 cycles to 1,510 cycles at 2 feet. At eight weeks she jumped and blinked at all these stimuli from a distance of 5 feet but she did not turn for the sound of a voice.

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These results are in line with those obtained with the infants in war nurseries. The tests did not prove that the child could not hear the sound of a voice but only that at the time of the test she did not respond to it. It was therefore suggested to the mother that she should sing, coo and speak quietly but close to the baby's ears and to take advantage of every natural opportunity of encouraging her baby to listen to her voice.

This baby was 0·8 years old at her next visit. Further tests of hearing were made, the results of which are given below :—

i. She responded to her name without hesitation every time it was called by her mother in an *mf* voice from a distance of about 3 feet.

ii. She looked up and turned when the writers called her name from time to time.

iii. She responded to her mother's repetition (*mf* within 3 feet) of the words " Pat a cake, pat a cake " by bringing her hands together.

iv. When leaving the clinic at the word " Bye, bye " she raised her hand to her mouth and tried to blow a kiss.

v. She turned and looked up at the sound of ' sh ' (*mf* at 3 feet).

vi. Percussion sounds all evoked reflex and learned response ; blinking, jerking head and turning.

vii. Pitchpipes won no sure response.

viii. Whispered speech was ignored.

It is not yet possible to say that this child has normal capacity to hear, but it is clear that she can learn to comprehend speech in the ordinary way provided that it is spoken in an *mf* voice within a distance of 3 feet.

G.H., an illegitimate child who was adopted on approbation by a young married woman who had no children of her own. At 12 weeks G.H. was referred to us by a doctor because the foster mother had noticed that the baby " paid attention to lights but never seemed to take notice of any sounds ". Subsequent tests showed that she was, in fact severely deaf. The foster-mother did not wish to adopt a deaf child. Her sole object was to have " a little one chattering and living in the home ". The legal procedure was therefore stopped until the child was somewhat older and could undergo further tests. Unfortunately these confirmed the suspicions of deafness. Another child was therefore selected for adoption, who was also brought to the clinic for tests of hearing, the results of which gave confirmative evidence that she could hear satisfactorily.

In this part of our survey 170 unselected cases are dealt with. They were all referred to us privately or to the Clinic for the Deaf at Manchester University because deafness was suspected or feared. The distribution by age and sex of the children was as follows :—

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TABLE II.  
CHILDREN SUSPECTED OF DEAFNESS

Age (years)	Boys	Girls	Total
0.0 to 0.11	5	10	15
1.0 to 1.11	23	15	38
2.0 to 2.11	30	15	45
3.0 to 3.11	23	16	39
4.0 to 4.11	20	13	33
Totals	101	69	170

## Tests of Hearing

*Ages 0.0 years to 0.11 years*

The procedure and stimuli were similar to those described for the infants of this age in war nurseries.

	Not deaf	5
RESULTS OF TESTS	Totally deaf	6
	Partially or severely deaf	4

The term partially deaf is used to describe a child whose hearing is impaired. As a rule an *mf* voice is audible to him at 3 feet but only a few words are intelligible to him at that distance.

A severely deaf child possesses only an island of hearing for very loud sounds. He can just hear an *ff* voice at 1 to 2 feet.

All the children in this group have been under our observation since their first test. The diagnosis made in every case has been confirmed by subsequent tests. Two of the babies appeared at first to be severely deaf but later were shown to hear more than at the first test. Neither heard enough to talk in the ordinary way.

As would be expected there were certain differences in the behaviour and response between the deaf and the ordinary babies.

Reflex response persisted for a longer period in the partially and severely deaf children. This was likely because the babies with impaired acuity had heard fewer sounds and had fewer opportunities of connecting such sounds as they could hear with their meaning.

None of these babies located the sounds they heard. They would blink, jump, look up; their facial expression would change but no child turned his eyes or his head in the direction of the sound when he first heard it. We do not as yet feel that we can say to what extent partial deafness may delay the acquisition of skill in perceiving differences in the physical characteristics of sounds. There was no evidence of this kind of discrimination in any of the deaf babies under 12 months.

## Conclusions

- If a child does not respond to the sound of voice by the end of the first year he is either deaf or has some other form of gross defect.



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ii. If it is shown that a child never turns his eyes or head towards a familiar person calling his name in an *mf* voice he is likely to be totally or severely deaf.

iii. The existence of residual capacity to hear loud sounds can be proved by a deaf child's reflex and learned response to a range of very loud stimuli.

iv. A partially deaf child's deprivation of opportunities of hearing and his inability to locate sounds from sources that are invisible to him tend to limit and delay the process by which they normally become meaningful.

### *Age 1·0 years to 1·11 years*

This group consisted of thirty-eight children of whom four were reported to have acquired deafness within the first year: three from meningitis and one from measles.

Again the procedure for the tests followed as far as possible that used with children of the same age in the war nurseries. The response of the youngest deaf babies in this group did not differ noticeably from that of the older babies in Group A. Such differences in behaviour as there were, did not, as a rule, appear suddenly at a given age. Most of them emerged into view gradually. One child of 15 months might prefer to play with toys while he was being nursed during the tests but another child of the same age might choose to sit on the floor and play there independently. Mere manipulation of toys would engage the attention of one child, while a younger one would play more purposefully.

As with the children in the war nurseries these variations indicated individual differences in mental ability, personality and attitude. When deafness was most severe there was a tendency for the child to vocalize less during his second than during his first year. But the ordinary babies used their voices more and more as they grew older and the sounds they made contained many learnt patterns which had at least some approximation to words. As a rule the partially deaf babies continued to vocalize freely but their efforts did not include many, if any, learned patterns. From 1·8 years to 2 years still more pronounced indications of dumbness became apparent in the behaviour of the severely and totally deaf children. They made their wants known mainly by pointing, pulling and pushing. The partially deaf children also did this, but as a rule they used their voices at the same time.

These findings are mentioned here because it must be emphasized that from the first year onwards our grounds for diagnosis of deafness, or of aphasia, are based upon observation of all aspects of a child's behaviour as well as upon his reaction to specific form of stimuli. As for the children in war nurseries we always began by calling the child

## Deafness in Infancy and Early Childhood

by name. If he failed to respond to speech we resorted to tests of voice, meaningful sounds, percussion sounds and pitchpipes, but from time to time throughout the tests we used the child's name and spoke to him. The co-operation of the ordinary children was mainly brought about through speech, either the matron's or ours, but the co-operation and confidence of a deaf child or one whose speech development is retarded for other reasons than deafness, had to be won by different means. The situation as a whole was always made to appear attractive, e.g. in our clinic Dobbin on wheels invariably won the interest and confidence of every child in this group. Dobbin helped to steady the little staggerers just beginning to walk. He gave them support and at the same time encouraged them to be venturesome, or Dobbin, propelled by the child's mother took him for a ride. Dobbin and his possibilities so suggestive of freedom and movement never failed to give confidence to a child in whom confidence could not be roused through words, and when a child's confidence was won and there were attractive toys about, co-operation followed naturally.

It was during co-operative play that we made our tests and observations. Thus gradually a reliable picture of the child's capacity or incapacity to hear was built up.

The results obtained from tests of this group are given below :—

Totally deaf	..	14
Severely deaf	..	18
Partially deaf	..	5
Blind and deaf	..	1
Not deaf	..	0
		—
		38
		—

The little blind-deaf child must be considered separately. At first it was thought that such slow development as she made might indicate mental deficiency. Subsequent visits have proved that although she is denied the two most vital forms of mental stimulation she is developing steadily but slowly. At 1·8 years she could not sit up unsupported but at 3·5 years she was almost walking without help. She moved about the room by holding on to the furniture.

It will be remembered that Helen Keller, whose cultural achievement is one of the miracles of our time, tells in *The Story of My Life* that she both heard and saw normally in infancy. She had begun to talk and to walk before an illness at 1·7 years robbed her of both sight and hearing. Our little patient is faced with a still heavier handicap for she was born deaf and blind. It is not yet possible to say with certainty whether she is severely or totally deaf.

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## Conclusions

i. The tests proved reliable for ascertaining gross defects of hearing. This has been substantiated by a follow up of cases.

ii. Reflex response is of much more frequent occurrence than with ordinary children of the same age.

iii. All children except the totally deaf responded to the sound of an *ff* voice at one foot.

No child in this group could locate any sound the first time he heard it.

iv. Reflex response changed more quickly to learned response than in the case of the younger deaf children. All who were shown to possess some residual capacity to hear learnt very quickly to associate a sound with its source when it could be seen. It was interesting to note the ways in which sounds became meaningful, during the tests, to the partially and severely deaf children. Their rate of learning constantly astonished us. For example, a child might jump or jump and blink at the beat of the drum, but fail to turn his eyes or head in the direction of the sound, which had been made from a distance of two to three feet from behind his head. Then one of us would beat the drum again but this time so that he could see the action as well as hear the sound. When, after a short interval the drum was beaten once more from behind the child, he would turn to look at it or at the person whom he had just seen beat it.

v. The tests yielded reliable but only approximate information about the range of frequency and intensity over which a partially or severely deaf child could hear.

### *Age 2·0 years to 2·11 years*

All of the 45 children in this group were brought to our clinic because they were dumb or backward in talking. They were all just as capable of running about independently and of manipulating play material purposefully as the children of the same age in the war nurseries. The form of their play, however, was sometimes somewhat different. It appeared to be much less imaginative. Bricks might be piled on top of each other with marked dexterity but they would not be used spontaneously to make a train. Evidence of the influence of the suggestions of adults and of other children was conspicuously absent in most cases.

As always we began by speaking to each child. We asked him and his mother (or father) to sit at a kindergarten table on which was placed an attractive manipulative toy. We made use of a number of such toys in our tests, the most popular and useful of which are described below :—

i. Gaily coloured stumpies. These are differently coloured small light stumps of wood which fit into coloured holes to match.

ii. A firm, large pyramid built of brightly coloured rings which fit on a central rod.

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iii. A block containing sockets of different sizes into which cylinders are to be fitted.

iv. A board of differently coloured reels that fit on to fixed pegs which match the reels.

v. A large nest of bricks.

All these toys can be used in several different ways : the stumps and the reels can be taken out and replaced or they can be matched to, and replaced into, the holes of their own colour. The nest of bricks and the cylinders offer opportunities for mere manipulation or for judgment and arrangement according to size. The pyramid gives a child the chance to combine selection according both to colour and size.

Thus the same apparatus is suitable for use with all the children between the ages of 1·6 years and 4·11 years.

With the younger children we usually began with the stumps. Either the mother or one of us began to take them out of their holes and to replace them one at a time. It was rare for a child not to want to join in. As soon as he showed interest in play we began to make the tests. If his interest in a toy flagged we changed it for another. Our object was to get him to co-operate in play either with his mother or with us, e.g. he and his mother took out a stump or a cylinder in turn. His capacity (if any) to comprehend speech was tested during this kind of co-operative play. "Brian you put one in"; "Now mummy will put one in"; "There is a stump on the floor"; "Pick it up, Brian".

When a child failed to respond to any of our or his mother's suggestions we proceeded to make voice tests and tests with percussion toys and pitchpipes from behind his head. If he failed to respond to any of these, we offered him the drum to beat, the bell to ring and the pitchpipes to blow. The children who could hear the sounds they made appeared to be interested in them and wanted to repeat their performances again and again. But the children who could not hear the sound of the drum, bell or pitchpipes lost interest in them very quickly. In some instances they failed to beat the drum vigorously enough to make it sound, or they would beat its edge and not the vellum. In most cases the children who proved to be totally deaf would put a pitchpipe to their lips but would produce no sound.

Five of the children who possessed some residual capacity to hear achieved better results at their second or third visit than at their first. The final results of the tests are given below :—

Totally deaf	..	15
Severely deaf	..	13
Partially deaf	..	13
Not deaf	.. ..	4

This step was necessary in preparation for the change over from male to female voice which would be made from time to time during speech and voice tests. When this point in the child's training had been reached the tests proper were made.

Sometimes it was possible to carry out the whole of the training and also to complete the tests at the first visit. With other children we gave the preliminary training at the first visit, rehearsed it and made the tests at the second visit. In some of the more difficult cases we were not able to complete reliable tests until the third or fourth visit. The period of training for the 3.0 to 3.6 year olds was always short and as a rule was interspersed with opportunities of free play but always with a toy we did not use in the tests. We never attempted to make the actual tests until a child understood fully what he was expected to do, was willing to co-operate with us and was interested in the response activity itself and we were careful never to expect a child to perform a response activity which he found difficult and could not do without hesitation. If, for example, a four-year-old could not match colour easily, we were content with a simpler response activity.

As has been stated already, we wanted to find out as accurately as possible each child's best capacity or residual capacity to hear speech. All our preliminary training, therefore, was planned to encourage and to win from the child his best effort in every direction. In the waiting-room he was given toys to play with, but not of course toys similar to those we used for the tests. None of us wore uniform. White coats were conspicuously absent because we did not want to remind a child of any possible painful past experiences such as mastoid operation, meningitis or even a visit to the dentist. It must be remembered that no ordinary child is ever brought to our clinic for tests. The majority of those who come live in a puzzling world because they lack normal habits of speech and of comprehending speech. We tried therefore to make the situation as easy and comfortable as possible for all the children but that is not to suggest that we followed a policy of appeasement, in our dealings with them. Far from it, but from the beginning we set out to rouse their interest in themselves and in us through our attitude towards them and the situation as a whole as well as through simple teaching.

*Tests of hearing.* The visible signals referred to earlier became of course the auditory stimuli used in making the tests. If during the training procedure a child had shown that he comprehended our speech in whole or in part, we began with speech tests. If a child had appeared to hear only a few words or sounds we began with the "Go" test. If a child had appeared to be severely or totally deaf, we began with the percussion toys and pitchpipes.

(a) *Speech tests.* Here we had two aims in view, to formulate an opinion about a child's capacity to :—

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- i. Comprehend speech at a distance ;
- ii. Hear and identify sample vowels and consonants.
- i. Suitable commands spoken in an *ff*, *mf*, and *pp* voice and whispered speech respectively, relating to the toys and always requiring an appropriate response activity from the child, e.g. "Put the smallest cylinder into its hole"; "Now the one next to it"; "And now the biggest one of all". "Find the blue reel and put it on the peg it matches." The commands were always well within the child's ability to fulfil and were spoken so as to test his response to speech at different levels of loudness and also to a male and female voice.
- ii. Whispered commands from a distance of 6 feet.
- iii. Tests of acuity for sample vowels and consonants. The child was asked to perform one of the response activities he had already practised every time he heard a sound. He was told that some sounds might be very quiet and others might be loud. As a rule the sample vowels and diphthongs included "ah", "oo", "ee", "ay", "oh" spoken and whispered by male and female voices from a distance of 6 feet or nearer if required. The consonants used included s, sh, f, th, p, t, k, (the names of the consonants were not of course repeated, but only their phonetic values).

All the children shown to have normal capacity to hear, like those in war nurseries fulfilled both of these tests without failing to respond to any whispered vowel or consonant.

The next test which was only given to the children whose hearing had so far proved to be normal was primarily a test of auditory discrimination. The child was asked to repeat the sound he heard.

i. Vowels and diphthongs—spoken from behind as before. No child failed to repeat a vowel or diphthong that he had just heard spoken or whispered but the pronunciation of some of the children showed traces of local patterns.

ii. Consonants. Every child failed to repeat all or some of the consonants which by his response activity he had shown again and again that he could hear. Failure to imitate consonants clearly was not due to deafness but to some other cause.

Further tests of auditory discrimination were given to the majority of these children, but this is not the place in which to describe them as they cannot be classed as tests of hearing.

(b) *Voice tests.* These were given to the children who failed to follow speech but who had responded to the "Go" test during their period of training.

i. "Go" test spoken in an *ff* voice. If the child responded affirmatively as shown by his response activity further tests were made to ascertain the maximum distance at which he could hear an *mf* and (if possible) a *pp* voice.

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ii. Vowel and Consonant test. All of the children who could not follow speech but who had responded well to the "Go" test proved able to hear a few vowels and consonants.

For this test the sample vowels and consonants already mentioned were used particularly "sh" and "s".

Response to "sh" gave a rough indication of some capacity to hear over a range of frequencies in the middle part of the speech range, while response to "s" indicated some hearing for the higher frequencies involved in speech.

(c) Tests with bells, drum, pitchpipes and other meaningful sounds. These tests were given to all the children examined. They yielded valuable information about a child's interest in and reaction to sounds in general and also in the case of the partially and severely deaf children about their range of residual capacity to hear.

Throughout the tests we made it a rule, that, whenever a child with any degree of hearing appeared to be unsure about a sound, it was repeated immediately in front of him so that he could associate it with its source. After an interval the test was repeated but the sound was made behind the child and when he was not expecting it. When a child failed to respond to any of the test sounds and total deafness was indicated, he and his mother were given immediate reassurance by proving in practice once more that he could fulfil all that was asked of him during the tests by watching for visible signals instead of listening to sounds. Such assurance is vital both to the child and to the parents for it involves a principle which is basic to the child's future development through educational treatment.

*Pure-tone audiometric tests.* We found that some of the older children among those who proved to be either not deaf at all or partially deaf, like the older children in the war nurseries, learnt quickly to respond to loud or fairly loud pure-tone stimuli but that they were not interested in listening to such meaningless sounds. The audiometer in itself roused little or no interest and the children's attention was apt to wander. Our experiments showed that except in three or four cases of very intelligent partially deaf children it was not possible to obtain threshold readings.

## Conclusions

i. The tests proved to be a reliable means of detecting deafness in children who were dumb or whose speech development was retarded or whose pronunciation was characterized by defects that were not due to the influence of local speech patterns.

2. From the results of the tests it was possible to form an opinion about the kind of special educational treatment each child needed.

# Deafness in Infancy and Early Childhood

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## APPENDIX. Summary of Results.

### THE CHILDREN IN WAR NURSERIES

Age (years)	Stimuli from 6 feet	Response
0 0 to 0 2	i Percussion Sounds } ii Pitchpipe sounds } iii Voice, <i>pp</i> , <i>mf</i> , <i>ff</i>	Reflex blinking, jerking head, screwing up eyes, twitching fingers No reflex Occasionally turning
0 3 to 0 6	i Voice <i>pp</i> , <i>mf</i> , <i>ff</i> ii Percussion sounds } iii Pitchpipes	No reflex Turning and attempts to localize sound Reflex and learned (turning)
0 6 to 0 11	i Voice, <i>pp</i> , <i>mf</i> , <i>ff</i> ii Quiet meaningful sounds } iii Percussion sounds } iv Pitchpipes	Turning or looking up Skill in locating and discriminat ing between sounds steadily de veloping
1 0 to 1 11	i Speech Own name and simple com- mands <i>pp</i> voice wins quicker response than loud voice Whispered speech ii Meaningful sounds } iii Percussion sounds } iv Pitchpipes v Very loud sounds	Turning for own name Some simple commands fulfilled. No response Sometimes located Sometimes ignored Reflex occasionally and turning sometimes ignored
2 0 to 2 11	i <i>mf</i> speech (simple commands) Give one to matron", etc ii <i>pp</i> speech iii Meaningful noises iv Percussion sounds <i>ff</i> v Pitchpipes	Commands fulfilled Commands located, fulfilled Won quick response if they interested the child Reflexes seldom appeared Sounds often ignored Frequent response to a range frequency



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Age (years)	Stimuli from 6 feet.	Response.
3.0 to 4.11	i. Conversation <i>mf</i> . ii. Commands <i>pp</i> e.g. "Now put another brick on top". iii. Whispered speech. iv. Sample vowels and consonants. v. Pitchpipes <i>pp</i> . vi. Pure tones.	Carried on conversation comfortably while playing. Appropriate commands fulfilled. Whispered commands fulfilled. Response activity to them all. Response activity to them all. Failed to interest child for long enough to obtain reliable threshold readings.

## PARTIALLY DEAF CHILDREN

Age (years)	Stimuli from 3-4 feet.	Response.
0.0 to 0.3	i. Percussion sounds. ii. Pitchpipes. iii. Voice, <i>ff</i> .	Reflex to bell and drum, blinking, jerking head, screwing up eyes, etc. Reflex, if any. No response.
0.3 to 0.11	i. Voice, <i>ff</i> and <i>mf</i> . ii. Percussion sounds <i>ff</i> . iii. Pitchpipes. iv. Meaningful sounds.	Learned response, turning or looking up, if any. Reflex accompanied by learned response. Reflex and learned, if any. No response.
1.0 to 1.11	i. Speech (own name). ii. Voice <i>ff</i> . <i>mf</i> at 1 foot. <i>pp</i> at 1 foot. iii. Percussion sounds. iv. Pitchpipes. v. Meaningful sounds.	No certain response. Turning but not locating. Frequent turning but not locating. No response. Reflex and/or learned response. Occasional response. No sounds located but their source often identified through visible clues.
2.0 to 2.11	i. Speech <i>ff</i> . Own name. Simple commands. ii. Voice <i>ff</i> . <i>mf</i> . <i>pp</i> . iii. Pitchpipes 120 to 1900. iv. Percussion sounds.	No response to conversation. Response in a few cases. A few simple commands were fulfilled in 3 cases only. Turning but not locating. Response in some cases only. No response. Turning to all or some. Still sometimes reflex and turning. Sometimes ignored, sometimes not heard, difficult to know which at this stage.
3.0 to 4.11	i. Conversation. ii. Own name and some commands <i>ff</i> and <i>mf</i> . iii. Voice <i>ff</i> . <i>mf</i> . <i>pp</i> . iv. Sample vowels <i>ff</i> and <i>mf</i> . v. Sample consonants. vi. Pitchpipes 120-1900. vii. Percussion sounds. viii. Pure tones.	None. In a few cases only—turning and looking up. Depended upon degree of residual capacity to hear and opportunities of learning. Certain response activity and turning or both. Frequent response activity and turning. Occasional response activity. Response activity to some or all. Frequent response activity to "sh" and sometimes to "s". No response to other breath consonants. Response activity to some or all. Response activity to all. Unsatisfactory response. Threshold readings not obtained.

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## SEVERELY DEAF CHILDREN

Age (years)	Stimuli 1 2 feet	Response
0 0 to 0 II	i Percussion sounds <i>ff</i> (drum and bell)	Reflex response
	ii Pitchpipes	Reflex response if any
	iii Voice <i>ff</i> at 1 foot	Reflex and/or learned response
1 0 to 1 II	i Percussion sounds <i>ff</i>	Still reflex and/or learned
	ii Pitchpipes	Reflex or learned to one or two only
	iii Voice <i>ff</i> at 1 foot <i>mf</i> at 1 foot	Learned—turning but not locating No response
2 0 to 2 II	i Own name <i>ff</i>	No response
	ii Voice <i>ff</i> at 1 foot <i>mf</i> at 1 foot	Turning but not locating No response
	iii Percussion sounds	Reflex and learned
	iv Pitchpipes	Turning for one or two only but not locating
3 0 to 4 II	i Name <i>ff</i> at 1 foot	No activity response unless to mere sound of voice
	ii Voice <i>ff</i> at 1 foot	Activity response and turning or looking up
	iii Sample vowels	Activity response to one or two only
	iv Sample consonants	No response
	v Percussion sounds	Activity response and turning but not locating
	vi Pitchpipes	Activity response to one or two only

## TOTALLY DEAF CHILDREN

Age (years)	Stimuli at 1 foot	Response
0 0 to 4 II	All forms of aural stimuli	No response

## MÉNIÈRE'S DISEASE

### THE RESULTS OF THE TREATMENT OF SIXTY CASES BY ALCOHOL INJECTION THROUGH THE FOOTPLATE OF THE STAPES

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From the Department of Laryngology, University of Bristol, under a grant from the Nuffield Trust.

ENOUGH experience has accumulated at the hands of many observers, since Lake (1904) first operated on the labyrinth for vertigo 40 years ago, to make it certain that such operations will cure the acute vertiginous attacks associated with Ménière's disease, always provided of course, that the responsible end-organ has been adequately dealt with.

At first sight it would have seemed essential to destroy completely the nerve elements involved but more recent experience shows that this is not necessary.

Thus in the Portmann operation in which the saccus only is opened and in the series reported recently by Cawthorne (1943), in which a small segment of a canal is ablated, the results produced are satisfactory.

It would seem therefore that if a communication be established between the endo- and peri-lymphatic spaces the desired result will be attained.

One serious drawback to the various operations employed, whether for the division of the vestibular nerve or for an approach to the saccus or vestibular apparatus, is that they involve a proceeding of some severity and technical difficulty.

Ten years ago the idea of a more direct approach occurred to me and after some experimental work on the cadaver I came to the conclusion that it should be possible to enter the vestibule with a needle through the stapes footplate. I first carried out this manœuvre on a patient in 1935 (No. 5). An injection of 1 c.c. of absolute alcohol was made with a dental anæsthetic syringe under general anæsthesia. This case was successful as far as the cure of the vertigo was concerned, but to my great regret, owing to the use of an excess of alcohol, she was left with a permanent facial palsy and in addition had a middle-ear suppuration which lasted for a period of three months. I showed this case at a meeting of this

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Section in 1935 (Wright, 1936) and she remains free from vertigo at the present time

This successful disaster led me to a careful consideration of the technique and it was only after a further period of two years of experimentation that I felt justified in repeating the operation

During this interval I evolved and eventually published a somewhat complicated technique (Wright, 1938) which as a result of further experience I have now simplified (Wright, 1942)

*Technique of Operation* The operation, the results of which I am now giving, consists essentially in the injection of a small quantity (not more than two minims) of alcohol by means of a special syringe through a perforation in the footplate of the stapes into the vestibule

The degree to which the alcohol fills the labyrinth, and therefore the amount of destruction produced, is probably variable

The stapes is discovered by probing with the needle in its general situation the tactile sensation produced by perforating this bone and then passing onwards for 2 mm being characteristic It is most important that those who wish to employ this operation should gain experience of these tactile sensations previously in the post mortem room

I consider that the use of special instruments is of importance, thus the aural speculum should have a lateral opening so that the shortest possible length of needle may be used This needle should be bent at an angle and be without a point A sharp needle will be found to catch in the soft tissues or bone, thus preventing appreciation of piercing the footplate

I have found the special syringe, which is spring operated with a trigger release, to be of great assistance enabling the operator to employ his tactile sense to the utmost

Not more than 2 minims of alcohol should be injected and it is helpful to have this coloured with methylene blue so that its escape into the middle ear or elsewhere can be recognized

A general anæsthetic would seem to be essential but need only be of the briefest duration

A careful watch should be kept on the patient's face by the anæsthetist so that should the needle touch the facial nerve the resulting twitch will give warning and the injection not be made

A towel with a central opening for the pinna allows the patient's face to be illuminated with the avoidance of dazzle to the operator

I have been unable to detect any immediate reaction in the patient to show whether the vestibule has been entered or not

On returning to consciousness the patient shows all the usual signs of an acute vestibular disturbance but this varies greatly As Cawthorne (1943) has pointed out this is probably due to the variability in the amount of functioning end organ remaining before the operation

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In some of the cases a certain amount of watery discharge has occurred for a period of days due either to the irritative effect of the alcohol on the middle-ear lining or possibly to a perilymph leakage. In no case has this discharge persisted for more than a brief period with the exception of the first case mentioned in which an excess of alcohol was injected.

It is my practice to get the patient out of bed on the fourth or fifth day and out of hospital in from ten days to a fortnight. The rapidity with which the individual readjusts to the loss of a labyrinth varies greatly, but in all cases this readjustment is most difficult under conditions of darkness.

I entirely agree with Cawthorne as to the usefulness of a specially designed physiotherapy during the period of rehabilitation: As an example of its importance I should mention the case of a railway employee from Swindon. Having returned from Bristol to Swindon apparently doing well and within a fortnight of the injection, he remained for six months off work tottering once weekly to the doctor's surgery for a certificate. As a result of re-admission to hospital with active physiotherapy for three weeks he returned to work and has continued so up to the present time.

In this series of cases I have failed to enter the labyrinth on five occasions at the first attempt. Of these five cases I was successful on the second attempt in three, (Nos. 31, 35, 49) and on the third attempt in one case (No. 4). The fifth represents one of the failures reported (No. 39).

These preliminary failures with one single exception occurred during my early experience with the operation.

I have now performed this operation on 60 cases and present the results in a similar form to those given to this Section by Cawthorne (1943) so that they may be comparable and in the summary below I have included his figures in brackets.

The detail of results obtained in individual cases is appended at the end of this article.

### TYPE OF CASE

Age—40 and under	..	9	(16)
over 40	..	32	(36)
over 60	..	11	(3)
over 70	..	8	(none)

The above figures demonstrate rather dramatically one important advantage of this little operation, i.e. that in view of its trivial nature it can be employed with little regard to the patient's age or physical condition.

Sex—Male	..	28	(33)
Female	..	32	(19)

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## Duration of Symptoms—

Under two years	..	24	(21)
Over two years	..	34	(31)

The results are only recorded in regard to the two symptoms of vertigo and tinnitus.

As far as hearing in the other ear is concerned sufficient detail has not been obtained to allow of any deduction but on one or two occasions patients have volunteered that they seemed to be hearing better owing to the diminution or absence of disturbing noises in the bad ear.

## RESULTS

<i>Vertigo</i> —Improved	..	55	(46)
Not improved	..	5	(4)
		—	—
Total	..	60	50
		—	—
<i>Tinnitus</i> —Improved	..	33	(22)
Not improved	..	16	(24)
Unrecorded	..	9	(4)
		—	—
Total	..	58	(50)
		—	—

The remaining two cases were free from tinnitus before and after the operation.

It will be seen that Cawthorne's figures and my own bear a very close resemblance.

It is gratifying to note that in such a considerable proportion of cases a favourable influence is exerted on the tinnitus.

In regard to the five failures in which no improvement now exists, this in three is probably due to involvement of the other ear (Nos. 22, 25, 32) after intervals of six, five and three years respectively. In one case the operation was unsuccessful (No. 31) although a brisk post-operative reaction took place after the second attempt. I have had no opportunity of assessing the reason for this failure. The fifth is a Flying Officer of whose case I give further detail below (No. 19).

*Complications.* These consist of two cases of facial palsy and one of meningitis.

As I have mentioned, the first case operated on has a permanent facial palsy. The second case of facial palsy occurred in the third of the series and cleared up in the course of a few weeks.

The history of the occurrence was as follows: W.M., Male, aged 51 (No. 35)—Four years vertigo and vomiting with deafness and tinnitus

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right ear, remnant of hearing in right ear. 30.8.37 right labyrinth injection. Facial twitch when needle inserted resulting in facial palsy but no vestibular upset. One week later injection repeated with vigorous reaction. Facial palsy cleared within three months and one year later reports no vertigo or tinnitus and at work.

Had I asked the anaesthetist to warn me of any facial movement on insertion of the needle this accident would not have taken place.

The case of meningitis was dramatic and somewhat puzzling: W.C., male, aged 45 (No. 44)—Left deafness and tinnitus with attacks of vertigo and vomiting for one year. 27.5.43 injection left labyrinth. Two months later, i.e. 18.7.43 admitted comatose with history of 24 hours headache and discharge from left ear for some weeks. Pneumococcus recovered from C.S.F. and condition rapidly resolved with chemotherapy. Left hospital on 2.8.43 apparently well and ear dry and healed. No vertigo. Three months later, i.e. 30.10.43 re-admitted—acute meningitis 24 hours duration. Ear still healed. Pneumococcus recovered from C.S.F. and rapid recovery with chemotherapy. One year later well and at work, no vertigo, no tinnitus.

This patient had some degree of chronic tonsillar and nasal sinus infection.

I was interested to note that in the discussion which took place at the meeting of this Section at which I showed my first case, Sidney Scott (1936) mentioned that he had had a case of fatal pneumococcal meningitis following on an alcohol injection through the external canal.

There are two cases which I should like to briefly relate. The first of these illustrates well the enormous benefit which such an operation can confer.

Mrs. M., aged 77 (No. 5)—For 28 years deafness right ear, severe vertigo, tinnitus and vomiting. Fallen on many occasions and on one fractured malar bone. Bedridden for four years. Has had double operation for glaucoma. Hearing—right ear nil, left normal. 22.12.41 right labyrinth injection. Two years later reports no vertigo, can get about and regards the injection as a miracle.

The second one raises a problem which is new to me, i.e. to what degree does the loss of a labyrinth interfere with an air pilot's efficiency: Captain H.H.P., aged 51 (No. 19)—Deafness right ear many years. No tinnitus. Two months severe rotatory vertigo and vomiting, getting worse. Hearing—right ear nil. Left—whispered voice six feet. Middle ears normal. Has been flying for 30 years but never giddy while flying. On 15.4.44 right labyrinth injection. Brisk reaction. Was flying again as co-pilot within a fortnight and after an interval of eight months reports has had several attacks, not so severe and only after flying. Slight unsteadiness on movement which is getting worse. No tinnitus and other ear as before. Has flown 60 hours since the injection.

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*Indications for the Operation* The advantages of this operation are that it is not dependent on the age or physical condition of the patient. Like other labyrinthine operations it does destroy any residual hearing in the ear concerned, but loss of hearing in one ear is not a severe disability and a trivial price to pay for the removal of acute vertiginous attacks. The rapidity with which relief is produced is also of great importance.

The outstanding drawback to all operations on the labyrinth or vestibular nerve is that no influence is exerted on the underlying cause of the disease so that the other side is liable to become involved at a later date.

Believing as I do that the disease is a local reaction to the toxins of infection I only operate on the labyrinth when an attempt at the elimination of such infection is found to be either inadvisable or unsuccessful.

In this relation I have on a few occasions combined a labyrinthine injection with tonsillectomy with the idea of avoiding subsequent involvement of the other side.

*Possible Future Development* The successful results obtained by Portmann's operation and the case of Cawthorne, in which the membranous labyrinth is opened but not destroyed, have made me wonder whether as a future development of my operation through the stapes, it would not be worth while trying either a simple needling which would certainly produce an opening of the membranous labyrinth or possibly this combined with some degree of suction.

It would seem theoretically possible that such a needling, by producing a communication between endolymph and perilymph spaces, might even produce some improvement in hearing combined with a relief of vertigo.

## Summary

An account is given of the essential details of the author's technique for the destruction of the vestibular end-organ by an alcohol injection through the stapes footplate.

Detail is given of the results in sixty cases over a period of ten years and these are compared with those of Cawthorne in which the membranous labyrinth is dealt with by the mastoid route.

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TABLE OF RESULTS.

No.	Name.	Sex.	Age.	Duration years.	Years elapsed.	Vertigo.	Tinnitus.	General State.
1	P.H.	M.	54	9	1	10/12	Slight on movement.	Normal life. At work.
2	M.F.	F.	61	4	2		Abolished.	Invalid. Cardiac asthma.
3	E.B.L.	F.	72	10	1		Abolished.	Normal life.
4	M.E.J.	F.	70	15	4		Slight occasional.	Normal life. (Three injections.)
5	M.M.	F.	50	32	3		Abolished.	Normal life. (Permanent F.P.)
6	E.M.V.	F.	72	1	3		Abolished.	Normal life.
7	F.M.B.	M.	45	18	5		Abolished.	Normal life. At work. Director.
8	E.W.	F.	53	14	5		Abolished.	Normal life. Climbs ladders and drives car.
9	G.M.	F.	77	28	2		Abolished.	Formerly bedridden. Now gets about.
10	W.R.I.	M.	43	10	1	9/12	Abolished.	Normal life. Schoolmaster.
11	L.R.G.	F.	53	29	2	7/12	Abolished.	Normal life.
12	M.B.	F.	44	5	2		Slight on movement.	Normal life.
13	M.G.	F.	64	11	2		Abolished.	Normal life.
14	V.I.C.	F.	32	3	4		Abolished.	Normal life.
15	F.L.	F.	49	21	5		Abolished.	Normal life.
16	M.P.	F.	59	9	8/12		Abolished.	Six years after injection involvement other ear.
17	M.V.B.	F.	70	4	1	2/12	Slight on movement.	Normal life.
18	W.K.C.	M.	63	2	6/12		Slight on movement.	Limited activities.
19	H.H.P.	M.	51	30	8/12		Attacks after flying.	Normal life. At work. Auctioneer.
20	W.E.	M.	72	9/12	6/12		Slight on movement.	Active flying duties.
21	F.M.Y.	F.	70	10	7/12		Abolished.	Normal life. At work.
22	L.C.	M.	50	1	6/12		Attacks less severe.	Normal life. At work.
23	C.W.	M.	68	1	10/12		Abolished.	Farmer's wife.
24	A.P.	F.	61	10/12	3		Abolished.	Involvement other ear. Not working.
25	J.V.	F.	64	?	3		Severe attacks.	Died of cerebral thrombosis 1 year after injection.
26	H.D.	M.	44	8	3/12		Abolished.	Normal life. At work. Nurse.
27	R.L.	F.	74	15	4		Abolished.	Involvement other ear. Not working.
28	W.G.	M.	36	15	5		Slight on movement.	Failed to follow up.
29	L.P.	F.	42	9	5		Abolished.	Normal life. Hears better, good ear.
30	A.G.	F.	66	2	2/12		Abolished.	Normal life. At work in factory.
							Unrecorded.	Failed to follow up.

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No	Name	Sex	Age	Duration years	Years elapsed	Vertigo	Tinnitus	General State
31	M R	F	45	6/12	3/12	Unaltered	Unrecorded	Failure cause (Two injections)
32	C D	F	64	3	6	Unaltered	Unchanged	Involvement other ear
33	R L	F	66	15	7	Slight on movement	Less	Normal life
34	G C	M	40	1	7	Abolished	Less	Working overtime
35	W M	M	51	4	1 2/12	Abolished	Abolished	Plumber (Transient)
36	R L	M	44	10	1	Abolished	Less	Normal life (Two injections)
37	G A	M	55	4	1	Abolished	Unrecorded	Normal life At work Gardener
38	H P	M	34	6/12	1 8/12	Slight occasional	Less	Normal life At work
39	S S	M	56	14	1 3/12	Slight occasional	Unchanged	Technical failure
40	M M P	F	45	2	1 9/12	Slight on movement	Unchanged	Normal life At work
41	V M	M	37	1	1 9/12	Slight on movement	Less	Normal life At work underground
42	A W	M	48	4	1 10/12	Abolished	Less	Normal life At work
43	C A	M	19	1	1 6/12	Abolished	Unrecorded	Serving in Navy
44	W C	M	45	1	1 7/12	Abolished	Abolished	Normal life At work (Two attacks meningitis)
45	L D	M	49	1	1 10/12	Slight on movement	Unchanged	Normal life At work
46	R B	F	56	2	1 5/12	Abolished	Less	Normal life At work
47	G P	M	55	2	1 5/12	Slight on movement	Unchanged	Normal life At work
48	J L	M	53	1 6/12	1 3/12	Slight on movement	Unchanged	Normal life At work (Two injections)
49	A W	F	62	10	11/12	Abolished	Less	Normal life At work
50	L P	F	33	2	11/12	Abolished	Less	Normal life At work
51	H J L	M	47	6/12	9/12	Abolished	Abolished	Normal life At work
52	C M C	F	50	7	10/12	Slight on movement	Less	Light work only
53	A D	F	38	6/12	4/12	Abolished	Less	Normal life At work
54	H D	F	59	6/12	7/12	Abolished	Less	Normal life Was bedridden
55	H B	M	50	2	3 8/12	Abolished	Unrecorded	Died hypertension and heart failure
56	G E S	F	46	9	2/12	Abolished	Unchanged	Early result
57	S W P	M	56	10	2/12	Abolished	Unrecorded	Early result
58	H J	M	33	16/12	5/12	Abolished	Less	Early result
59	M A J	F	64	5	5/12	Abolished	Unchanged	Early result
60	I P	M	44	18/12	3/12	Abolished	Unrecorded	Lately result

in two months. There was a reactionary rise of temperature to  $99.6^{\circ}$  and slight rise in pulse-rate lasting five days. There was a good deal of headache but the throbbing pain disappeared and the general condition rapidly improved. Cavity epithelialized rapidly and has remained dry.

16.12.44. Cavity dry and well epithelialized. There is a little "blueness" as of veins in the tympanic area. Hearing nil. Weber referred to left. Cold caloric test. A brisk normal reaction after 30 seconds.

A search of the literature, which does not claim to be complete, reveals records of similar cases by Bronzini, Arnold Jones, Schall and Scott. Arnold Jones when recording his case in 1930 states that he could find no other similar case reported in the literature but mentions cases having some resemblance reported by Beck, Calabresi, Fischer and Richman. I have verified the references of the last two but had not access to the others. The latest edition of Ewing's *Pathology of Tumours* mentions no tumour resembling these and they do not seem to fall into any of the five classes of hæmangeio-endothelioma described there. It would seem probable that the vasoformative elements of the tumour arise from the capillaries of the mucosa of the middle ear, either that covering the inner wall, or in one or two of the cases the mucosal lining of the tympanic membrane. Fischer suggests that the epithelial covering is derived from the outer surface of the drum membrane, and Richman, in whose case the tumour appears to have been of the membrane, agrees with him. Alternatively, there is no reason why the epithelium of a mucous protrusion should not have undergone change to the stratified type.

Beck's case is described as a hæmangeioma of the middle ear.

Bronzini's case was a man aged 40, complaining of unilateral deafness. The external meatus was filled with a "skin" covered tumour springing from the depth of the meatus which was dry. Removal was declined and there was no change after fourteen months. After three years however, the tumour was presenting in the concha and had invaded the middle ear and mastoid process. A radical mastoid was performed but the lymph glands had become involved and in spite of radium and X-ray treatment, the condition progressed to a fatal end five years from the date of the first visit.

Calabresi's case is described as a fibromyxoangeio-endothelioma of the middle ear.

Fischer describes a hæmangeioma of the drumhead.

Jones records fully a case of hæmangeioma of the middle ear. A large aural polypus bathed in pus was removed from a lady of sixty in 1922. Histological report was "a fibrous polypus growing rapidly in parts, possibly going on to sarcoma". Four years later there was again aural discharge with pain and a polypus was present. A radical mastoid was performed and the origin of the polypus traced to the inner tympanic wall. After removal "considerable and annoying hæmorrhage" was experienced from this situation. Drum and ossicles were almost destroyed and the antrum contained pus. Histological report on this polypus described a hæmangeiomatous structure and one area was suspicious although there was no definite evidence of malignancy. Subsequent history was of a dry clean cavity lined with epithelium after three months and no trouble up to 1930. This story closely resembles my CASE II. There was associated infection in both cases. May this not have been intercurrent,



FIG 1

Case 1 Hæmangeio-Endothelioma of Middle Ear



FIG. 2.

Case 2 Hæmangeio-Endothelioma of Middle Ear.

## Clinical Record

and the obstruction to drainage owing to the presence of the tumour have led to chronic suppuration in Jones' case and an acute mastoiditis requiring urgent surgery in mine

Richman reports a vascular tumour of the membrana tympani, which was shrunk to small size by radium treatment with improvement in hearing

Schall, in 1935, reported six cases of malignant tumour of the middle ear, in which he included two cases of hæmangeio endothelioma, which remained free of recurrence up to periods of five years. He remarks that such tumours while rare (1/6,000 of pathological conditions of ear seen at Massachusetts Eye and Ear Hospital) are far from medical curiosities. The treatment in all cases was radical operation followed by irradiation. Detailed case histories are not given. Of the two hæmangeio endotheliomata one was alive and well after four years, and one died of pneumonia after two years, the ear remaining free of recurrence.

Scott reported a hæmangeio endothelioma excised by diathermy. This case is of extreme interest as all stages of the tumour formation were observed.

In 1929 a woman aged 52 attended St Bartholomew's Hospital for deafness of the left ear, relieved by catheterization. Attendance continued for tinnitus of the right ear which had been deaf for twenty years. In 1934 there was again trouble in the left ear, the drum membrane was described as red and bulging. Paracentesis was performed but only blood "under pressure" escaped. Bleeding continued for one week, and four months later granulations were seen in or near the drum membrane. These coalesced and in six months appeared polypoid, and doubt was expressed as to whether they were inflammatory. Visits were discontinued for two years and operation refused until after three years by which time a pulsating bright red swelling completely blocked the deep meatus. Biopsy (Dr Magnus) showed this to be a hæmangeio-endothelioma. In 1938 tumour was excised through a post-aural incision by diathermy knife without opening mastoid or tympanum. In 1939 meatus free and intact and an inflatable membrane. Deafness on both sides indistinguishable from that due to otosclerosis. There is a close parallel between this case and my CASE I.

In all four cases where full histories are available, Jones', Scott's and the two here presented, the tumour obviously arose in the tympanic cavity and pushed its way through the drumhead. In three of them its origin was definitely traced to the inner tympanic wall. Scott's case seems likely to have arisen from the outer wall or membrane.

The deafness in CASE I and Scott's case was definitely middle ear. In Jones' case it is not mentioned, and in CASE II it appears to be of nerve type, but this may be the extreme phase of an otosclerotic change. That this is possible is suggested by the normal vestibular reaction. The transient facial weakness in CASE II was presumably due to inflammatory oedema.

In only one (Bronzini's) case of the nine mentioned here, was there a fatal termination due to the malignancy of the tumour but comparing this with others of which we have full case histories, it would appear to have progressed much farther before any action was taken. In several malignancy has been suspected histologically. It is probable that a number of these tumours are missed, so used have we become to the innocent character of aural polypi, and

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the fact that unfortunate sequelæ are hardly ever heard of is a favourable omen. Perhaps we would be well advised to have histological examinations made more often and at least we must suspect the polypoid swelling, however innocent in appearance, which is unaccompanied by infection. It would be well to realize also that a full red drumhead accompanied by pain is not invariably due to pus, especially if it is followed, with or without paracentesis, by an absence of discharge and polypus formation.

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# The Journal of Laryngology and Otology

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## EXPERIENCES OF A BLOODLESS TREATMENT FOR RECURRENS-PARALYSIS

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PALSY of the recurrent nerve occurs frequently after struma-operations. We know from the literature on this subject that these palsies are not always due to injuries to the nerve sustained during the operation (Rankin).<sup>22</sup>

Many authors (Amersbach)<sup>1</sup> believe therefore that disturbances of the circulation are sometimes responsible for this condition; particularly as the recurrent nerve is rich in sympathetic nerve elements. According to the less recent literature (Cisler)<sup>2</sup> more than 50% of the cases showed pareses or palsies in the region of the recurrent nerve after operations on the struma. This number has been remarkably reduced by modern surgical technique.

When the nerve is affected on both sides a fixation of the vocal cords in the median, paramedian\* or in the cadaveric position may present itself. Semon and Rosenbach believed that this is due to a weakness of the posticus. Herzog and his school however have stressed that this is not always the case after Gruenwald within a short period of time had found five cases with approximately equally heavy damage to the opener and the closer. A disciple of Herzog's, Roettger,<sup>24</sup> laid down the following: "According to our own experience and to the experience of others we definitely oppose the theory hitherto existing that in cases of defects of the glottis opener the vocal cord takes a median position, and that it remains immovable in this position. The clinical picture of palsy of the posticus is characterized rather by movements of the vocal cords, namely

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\* "Paramedian" meaning very close to the median position.



## Emil Froeschels

inward movements reaching the middle line and outward movements up to the cadaveric position. Therefore the influence of the musculus posticus consists in a widening of the glottis from the cadaveric position to the outside."

Roettger also stated that the stoppages of the vocal cords in the cadaveric position were often to be seen, but that microscopic investigations had seldom been undertaken (Joergen-Moeller, Kraus, Menzel, Klestadt, Herzog).

Before reporting on my therapy as regards breathing troubles in bilateral paralysis of the recurrent nerve I wish to point out the prognosis for such cases after surgical treatment.

According to the belief that a fixation of the vocal cords in the para- or intermedian position is based on a heavier injury to the muscles of the openers, the attempt has been made to combat the preponderance of the closers by a total resection of the recurrent nerve. (See Klestadt)<sup>13</sup>. This operation, however, has not shown the anticipated success, a fact which has been used as evidence against the viewpoint of Rosenbach and Semon.

Total extirpation of the vocal cords as carried out by Citelli<sup>3</sup> and Ivanoff<sup>8</sup> failed to yield good results, owing to the appearance of scar pads in the area of the vocal cords. (Moreover, the tragic results should not be forgotten, for in such cases the patients are affected with serious voice troubles. Since physiological voice production calls for a closing of the glottis, the paramedian position changes the voice very little if it causes any change at all.) Hoover<sup>7</sup> wrote a paper about this operation. Jackson<sup>9</sup> recommended ventriculo-corpectomy for laryngeal stenosis due to paralysis of the inferior laryngeal nerve. Menzel<sup>19</sup> curetted the recessus Morgagni, and extirpated the cord but was forced to perform a tracheotomy after five days, because of stenosis. Kosler<sup>14</sup> tried to effect shrinking to the side of the lateral parts of the vocal cords by means of a caustic substance and reported good results.

Amersbach was afraid that this deep reaching destruction might cause hæmorrhage. Payr<sup>21</sup> proposed to attain the opening of the vocal cords by implanting a piece of cartilage. Amersbach reported one case of Molinie in which the operator had made two deep parallel cuts from the top to the bottom through each thyroid cartilage and pressed the larynx from the front toward the back, thus procuring a widening of the glottis. This, however, proved not sufficient to permit a removal of the cannula.

Amersbach suggested that a window be cut into the thyroid cartilage in order to fix one end of the cord on to the musc. stylohyoideus, thus preventing the vocal cord from being drawn toward the middle line during breathing. This method, as far as I know, has not been successfully applied. Amersbach himself believed that it was very difficult to

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predict the best time for an operation of this kind. When the operation is performed too soon results which otherwise might be obtained are frustrated, when it is performed too late a fixation of the joints of the arytenoid cartilage may already have taken place.

Soyka<sup>25</sup> proceeded in the following manner: after having split the thyroid cartilage he clipped off a piece, and sewed it, wedge-like, into the front part of the glottis.

It may be well to describe this operative method in order to demonstrate the difficulties of all these surgical attempts to ease the patient's breathing troubles.

Tracheotomy was performed under local anæsthesia and followed by laryngo-fissure. Then a three sided lobe containing only perichondrium and cartilage, was cut from the left thyroid cartilage while the mucous membrane of the larynx remained untouched. The lobe was lifted and forced over the fourth side. Then a piece of the perichondrium was cut off, and the lobe was placed into the opening of the laryngo-fissure. Thus the perichondrium which had been lying outside, was moved inside the larynx. The thyroids, however, showed a tendency to return to their previous position pushing the lobe from its frontal to a more sagittal place. The operator was therefore compelled to join the two thyroid cartilages with the external musculature by two sutures at the top and at the bottom. In this way he succeeded in creating a gap which enabled him to place the lobe of the cartilage in a frontal position and fix it there. After a short period of improvement, however, breathing became troublesome again. This was most probably due to the loosening of the sutures connecting the thyroid cartilage with the outer musculature, and causing the thyroids to return to their previous position. Tracheotomy was eventually inevitable.

The proposal of Marschik<sup>27</sup> to achieve neurotization of the musc. cricoarytænoideus posterior by its junction with the musc. omohyoideus has not yet proved successful.

Hajek<sup>6</sup> believed tracheotomy to be the best method. The patient learn to close the fistula temporarily by a turn of the head which enables them to speak.

Rethi<sup>23</sup> proposed to cut through the adductors, an operation which Kahler<sup>10</sup> also recommended. His cases, however, showed voice impediments after the operation.

Wittmaack's<sup>28</sup> amputation of the muscles inserting on the processus muscularis which causes the vocal cords to sink, seems to be successful.

King's<sup>12</sup> recently developed method has been recommended by several writers. This operation is executed in the following manner: "The cricoarytenoid joint is disarticulated, and the arytenoid cartilage displaced outward by a suture which surrounds the cartilage submucously,

and is passed through the lateral border of the thyroid cartilage. The omohyoid muscle is attached to the arytenoid cartilage for the purpose of further opening the cords during the inspiratory efforts."

Kelly<sup>17</sup> says that King's operation should be tried before any laryngeal procedure. McCall and Gardiner<sup>18</sup> recently have modified King's method.

Before describing a bloodless method for these troubles I wish to mention that this method can only be effective in cases in which the anatomic conditions permit a functional improvement. Recent findings to the effect that the nervus laryngeus superior is considered to be motor also encourage the application of a training method for the use of the motoric potential function of this nerve. Furthermore I would like to stress the fact that so far no clinical sign has been known which would allow with certainty to differentiate between an irreparable palsy and a reparable one (paresis). The persistence of the disturbance over a long period of time does not eliminate the possibility of recuperation. Amongst the cases which were successfully treated by my method were several which had been suffering from severe breathing defects for many months, even for years.

The reader may feel that in some cases the breathing troubles endanger the life of the patient, and that therefore nothing but an immediately effective treatment is desirable. This objection might hold true with exceptions though we have succeeded in all the cases treated in the way which we shall describe. Nevertheless, it must be conceded that in an exceptional case a momentary surgical intervention may prove inevitable. On the other hand, if no such procedure is indicated the bloodless treatment may first be tried, since, according to my experience, it shows its favourable effects within a short time.

The method which I recommend has been called "Pushing Exercises", and was introduced by me for palsy of the soft palate as far back as 1925. As the "Pushing Exercises" had proved highly successful they came into my mind when I was faced with cases of severe palsy of the inferior laryngeal nerve.

When standing in a manner permitting elasticity of the body the patient should energetically push his clenched fists from the chest as far downwards as possible.

It is necessary to make a downward movement so that the fists are finally close to the front of the thighs.

Special attention must be paid so that no stiffening in the joints involved occurs before the fists have reached the lowest possible line, that is to say that the elbows as well as the wrists should be entirely stretched at the end of the pushing.

If the patient is able to perform all that he should be asked to emit a vowel exactly synchronic with the downward pushing of his fists.

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Neither should the vowel appear before the fists are on their way down, nor after they have reached the lowest point.

The smallest deviation from these demands renders the whole method ineffective.

The exercises should be executed for half a minute to a minute not less than twenty times a day.

It is interesting that Negus<sup>20</sup> was able to observe an approach of the vocal cords towards each other in normal persons while they were clenching their fists. Griesman<sup>5</sup> verified this laryngoscopic observation of Negus by X-ray pictures.

One of the benefits this method offers to the patient is that—if it works at all—it does not interfere with the voice, since, with very few exceptions, it strengthens the openers of the glottis as well as the closers. The operative methods aim at fixing one vocal cord or both at least in the intermedian (cadaveric) position. This position, however, is not favourable for phonation though it may not render voice production impossible in cases in which only one cord is fixed in the para- or in the intermedian position. (See Froeschels: "Ueber eine neue Behandlungsmethode der Stimmstörungen bei einseitiger Rekurrenslähmung", *Monatsschrift fuer Ohrenheilkunde und Laryngo-Rhinologie*, 1932, lxvi, xi, pp. 1316-1320).

We used the pushing exercises in spite of the risk we were running when we first prescribed them. Since the law of Rosenbach-Semon, had by no means been disproved, (the reader is referred to Broeckaerts, Grossmann, Mehring, Zuntz, Riese,—quoted by Amersbach—Weleminsky,<sup>27</sup> Leichsenring,<sup>13</sup> D. Weiss,<sup>26</sup> etc.), it was uncertain whether it was not frequently the openers of the vocal cords that were affected rather than the closers. If this had been the case, the danger existed that the application of pushing exercises might strengthen the group of muscles which was already in a better functional condition, instead of the one which was more afflicted. In other words, tighter closure of the glottis after the pushing exercises was to be feared due to the more or less complete adduction-position of the vocal cords. However I remembered a case which had suffered from a defective closure of the glottis accompanied by aphonia. Following the pushing exercises—for the purpose of attaining a better closure—the opening function had been the first to appear (CASE I).

The first case history, therefore, will be presented to illustrate why, later on, we used this method for the strengthening of the glottis-openers. There was no need for that in this case. On the contrary, we intended to strengthen the closers.

CASE I. A domestic servant, 27 years old, came to us four months after she had undergone an operation for goitre. She was completely aphonic and despondent because of her "dumbness", and threatened to commit suicide.

After some fruitless attempts with older methods (electric treatment) I thought pushing exercises might be effective. After a few days of regular use of this method, the first movements of the vocal cords showed, but—outwards. This unwelcome result did not hinder us from continuing the therapy because we hoped that the pushing exercises which evidently strengthened the openers would also strengthen the closers. After a few days the first inward movement appeared, and after a year's treatment the voice was normal, the closure of the glottis perfect, and the patient even started singing lessons.

Therefore, in September 1933, I introduced pushing exercises for the first time in my Clinic (Department of the Viennese Clinic for Ear, Nose, and Throat) for the treatment of severe breathing difficulties after operations on the thyroid gland.

The history of the first case of difficult breathing treated with "pushing exercises" follows:

CASE II. M.F., 33 years old. Struma operation on August 29th, 1933. Serious breathing troubles which seemed to necessitate a tracheotomy if no other help could be found. September 22nd, 1933: during respiration both vocal cords were fixed between a para- and an intermedian (cadaveric) position. Total aphonia. Pushing exercises immediately produce a breathy, rather high voice. October 21st, 1933: distinct outward movements of the vocal cords during inspiration, which however were immediately preceded by a closure. November 3rd, 1933: during one week apparently normal closure of the glottis during phonation, but occasional sinking and minor narrowing of the epiglottis. Patient was feeling much better, breathing was sufficient, agony was removed. March 2nd, 1934: the left vocal cord reached the paramedian position during inhaling, the right vocal cord still was fixed in the intermedian (cadaveric) position. Breathing troubles had disappeared, the voice of the patient sounded normal. Checkup on January 19th, 1935: the left vocal cord reached the paramedian position during breathing, the right one passed the intermedian (cadaveric) position. The glottic chink was about 4 mm. wide.

CASE III. L.P., a worker, 48 years old. Had acquired sudden breathing troubles starting three months after a struma operation. One month later, on February 27th, 1934, she came to my department. Laryngoscopic findings were as follows: the right arytenoid was pushed forward, the vocal cord was fixed in a paramedian position. The left vocal cord was higher during breathing, moved very little beyond a paramedian position. The patient, a singer of folksongs, could sing only with great difficulty. Pushing exercises were applied immediately. March 14th: the right vocal cord passed the paramedian position during inspiration, while the left moved beyond the intermedian (cadaveric) position. May 20th: the right vocal cord did not move, the left, however, moved

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as it had done in a previous examination. No troubles. July 16th during inspiration the left vocal cord reached its normal place, yet the extension of the mobility of the right one changed during repeated observations. Checkup on January 14th, 1935 the left cord passed the cadaveric position during inspiration. In recent months, about every fourth week, the patient, in fear of continued troubled breathing, had been awakened from sleep by fright. This breathing fear might have been of a psychogenic nature, since the patient was free from trouble during hard work. Pushing exercises were taken up again, and the attacks disappeared.

CASE IV. A woman, 47 years old, had undergone an operation for goitre 10 months ago. She consulted me because of excessive breathing troubles. She was in extreme agony and could walk only with great difficulty. The breathing discomfort had increased ever since the operation. Laryngoscopic findings showed fixations near the median position of both the cords. The glottis was less than 1 mm wide. After one week the pushing exercises brought about distinct sideways movements of the vocal cords and a widening of the glottis base to about 3 mm. The patient felt very well, and could speak even while walking.

CASE V. F Sch, a clerk, had been stricken by a palsy of the recurrent nerve on both sides after a one-sided ligation of the jugular vein. The case had been demonstrated in the Rhino-Laryngol. Society of Vienna on June 26th, 1934, from the view point of otology and laryngology. On June 25th, 1934, both the cords were in a paramedian position before breathing. The right cord during inhaling moved very little to the outside, no movement of the left cord, the pitch of the speaking voice was very high—as is often the case in palsies of the recurrent nerve, about  $e^2$ , and the voice was very breathy. Pushing exercises were immediately applied. They brought about a widening of the glottis to over 2 mm within one month. Curiously enough, an action opposite to the norm took place during the breathing, at the beginning of the treatment. A complete normal voice was attained in the course of the treatment. A checkup on January 19th, 1935, showed the glottis basis about 4 mm during inspiration. The right cord performed the more active movements of inspiration but the left cord too had improved considerably. The patient felt very well.

It may be assumed in this case that there might have been a disappearance of symptoms without the exercises. However, this method should be applied even when a spontaneous disappearance of symptoms may be hoped for.

The following case histories, showing further examples of the probable influence of pushing exercises, will be given as short extracts only.

CASE VI. T Sch, 53 years old. First struma operation 1921. Second operation October 25th, 1935. Vocal cords in paramedian

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position on November 12th, 1935. Largest opening of the glottis 2 mm. Stridor during forced inspiration. Frequently narrowing of the glottis during inhaling. Beginning of the treatment on November 12th, 1935. Glottis  $2\frac{1}{2}$  to 3 mm. during inspiration, no narrowing on January 1st, 1936.

CASE VII. I.T., 60 years old. Struma operation in 1925, difficult breathing since. Right vocal cord fixed in paramedian position, left vocal cord mobile, moving to  $1\frac{1}{2}$  mm. outside the paramedian position on July 24th, 1935. Therefore widest opening of glottis almost 2 mm. On March 25th, 1936, width of the glottis 3 mm. No breathing troubles.

CASE VIII. T.B., 38 years old. Struma operation on September 20th, 1935. March 9th, 1936: left vocal cord fixed in paramedian position, right vocal cord showing good movability, slight breathing difficulties. High (eunuchoid) voice, average speaking pitch  $f'$ , the voice lower at times. March 30th, 1936: left arytenoid cartilage moved. May 5th: left cord mobile; voice treatment brought about a normal voice, no breathing troubles.

CASE IX. F.B., 55 years old. First struma operation in 1926. During three years after the operation the patient had only been able to whisper. Then the voice had come back but was hoarse and weak. Second struma operation January, 1933: severe breathing troubles, and a very weak voice. March 26th, 1936: left vocal cord fixed in paramedian position. Arytenoid cartilage bent to the anterior. Right vocal cord in paramedian position but slightly mobile (from  $\frac{1}{2}$  to 1 mm.). Weak voice. April 8th, 1936: during inspiration the right vocal cord reached almost intermedian (cadaveric) position. April 22nd: left cord immobile. Glottis could be opened to 3 mm. No breathing troubles, voice clear.

CASE X. E.Z., 58 years old. Struma operation April 2nd, 1936. Since then hoarse, breathing difficult. April 14th, 1936: right vocal cord fixed in paramedian position. Left vocal cord during inhalation moved to intermedian (cadaveric) position. April 23rd: right vocal cord began to move outwards. May 15th: right vocal cord mobile to intermedian (cadaveric) position; normal breathing.

CASE XI. A.P., 40 years old. Struma operation on April 7th, 1936. April 14th: hoarse voice. Both vocal cords fixed in paramedian line. Glottis width 1 mm. Right arytenoid cartilage made minute movements at the beginning of phonation. Difficult breathing. Inhaling and exhaling sounding  $f'$  during inhaling,  $e'$  during exhaling. April 23rd, 1936: glottis width 2 mm. May 5th: no breathing troubles, glottis  $2\frac{1}{2}$  mm. May 12th: the right vocal cord moved extensively during inhaling. Glottis 3 mm.

CASE XII. A 36 year old man had undergone a goitre operation in 1918, over 17 years previous to the beginning of our treatment. Breathing troubles had set in immediately after the operation. The patient had

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been transferred to the clinical department of Prof Hajek, who for many months had applied an electrical treatment. One year later, tracheotomy had become necessary, since the patient had been unable to move and had collapsed in the street. Since he refused to use a cannula, the resection of a piece of the left vocal cord had been performed and proved a complete failure. Later, in 1922, the stretching of the cords had been tried by Dr Marschik but the patient had permitted only a single stretching. Since he refused to undergo another operation and would not use a cannula, his condition had become very serious. He had not been able to walk up the three floors to his apartment in one stretch, and required a quarter of an hour to reach this landing. During the night, awakened by troublesome breathing, he had often been compelled to leave his bed, and to go to an open window for fresh air. Prof Hajek, whom one day he met in the street, had advised him to try the pushing exercises. At that time he had had a shortwave electric treatment after which Dr Herz, his physician, had noticed a slight but transient improvement of the voice and the breathing troubles.

When the patient was brought to our department examination showed a glottis of 2 mm width with minute mobility of the vocal cords.

The therapy consisting of pushing exercises was begun and carried on by Mrs Hedwig Hitschmann. The patient was treated for two months three times weekly, and between treatments did exercise frequently by himself. After a few months, efforts were made to improve his strongly paretic voice with exercises also.

The success with regard to his breathing was extraordinary.

The patient, a butcher, became perfectly able to work again. He walked up to his apartment without any strain, and later became a very active alpinist, climbing the Rax and the Schneeberg (about 6,000 feet high). While before the treatment he had had a constant longing for fresh air he became a cigarette smoker after the completion of the treatment. Before, he had only been able to count up to three with one breath while after the treatment he could count up to fourteen, which, though not normal, is sufficient.

I have described this case in detail because a cure can by no means be considered spontaneous when treatment is begun after breathing troubles have existed for a period of 17 years and 4 months.

The following two cases demonstrate the usefulness of the pushing exercises in "rheumatic" troubles on the recurrent nerve.

CASE XIII R H, 51 years old. Had been almost aphonic for five weeks, without any known reason. Great deal of mucous secretion. April 3rd, 1936 left vocal cord fixed in paramedian position. May 4th, 1936 left vocal cord mobile from paramedian position to the middle line.



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CASE XIV. K.S., 56 years old. Hoarse for two months. Cause unknown. April 3rd, 1936: left vocal cord fixed in paramedian position, slightly excavated. Right vocal cord normally mobile. May 15th, 1936: left cord mobile toward both the sides of paramedian position to an extent of  $\frac{1}{2}$  resp. 2 mm.

CASE XV. L.S., 38 years old, underwent a struma operation (adenoma) when she was 24 years old. Good speaking and singing voice before the operation. After operation, whispering for six weeks; then normal voice at first, later becoming rough and hoarse. She complained (more or less intermittently) of a tense feeling in the chest and the muscles of the throat.

A piping, snoring noise was present (almost regularly) during sleep, which no one could endure. Her neighbours complained, and she was turned out of every apartment. Seven months before she came to Dr. Rechnitzer (New York) with an attack of choking, she had feeling of tenseness and heaviness.

Laryngological diagnosis: fixation of both vocal cords near the medium line, vibration during inhaling. The vocal cords reaching the middle line during phonation. Slight mobility of the right cord, glottis  $1\frac{1}{2}$  mm. wide.

Dr. R. cautioned the therapist on the seriousness of the case, and of the necessity of tracheotomy in case of a cold.

Therapy (performed by Mrs. Olga Schnitzler): long exhaling, first without sound, later gliding down the scale of her voice, thus expanding the range; general relaxation, pushing exercises.

After three months the voice became clear, had a wider range, patient could sing nicely.

Dr. R.'s findings: glottis about  $2\frac{1}{2}$  mm. wide, improvement of the voice. Feeling of tenseness in the chest was eased but patient still complained of the "noise" during sleeping, although her sister reported it much better. Observation of the patient while asleep revealed a piping, snoring noise which ascended and then stopped entirely, to recommence after some minutes.

The cases described above were not the only ones treated with pushing exercises. Before March, 1938, forty-three patients had undergone this treatment, all with completely satisfying results as to breathing and voice production. None, except CASE III, showed signs of impairment after the regular treatment. Nevertheless, all patients were advised to do pushing exercises at least twice a day after their recovery.

In 1937, Dr. Luchsinger<sup>16</sup> described 10 cases of paralysis of the inferior laryngeal nerve, which were tracheotomized without previous use of my method. His eleventh case, a woman of 60 years, was too weak to be operated on, and Dr. Luchsinger tried the pushing exercises. After two weeks' treatment the patient's breathing improved sufficiently to eliminate any danger of suffocation.

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The method of "pushing exercises" is so simple that it should be used in every case of palsy of the recurrent nerve provided that no immediate danger to life exists. Moreover, I feel that after strumectomy every patient should be taught the correct way of performing the exercises, and should be persuaded to use them as soon as the healing process permits, at least ten times a day for one minute, in order to prevent a later possible appearance of palsy of the inferior laryngeal nerve. Experience has shown that such palsies develop weeks, or even months after the operation.

I believe that some of these incidents—though not all—can be prevented by this method.

As to the width of the glottis necessary for comfortable breathing  $2\frac{1}{2}$  to 3 mm proved to be sufficient. Since case XII succeeded in mountain climbing without any difficulty one may expect this width of the glottis to be adequate even for hard work.

Any assumption that in some cases the symptoms may have disappeared without any training—(as frequently proved by E. I. Greene<sup>4</sup> f 1)—does not contra indicate the use of the pushing exercises considering their simplicity and harmlessness. So much the more so as a spontaneous restitution can never be predicted.

In conclusion, I wish to make it clear again that I do not consider the pushing exercises to be effective in cases of paralysis due to an irreparable anatomic destruction. But such a destruction cannot be diagnosed with our clinical methods. This fact too indicates the pushing exercises in all cases of impaired or missing mobility of the muscles innervated by the recurrent nerve if no immediate surgical indication prevails.

## Summary

(1) The clinical picture after injuries to the recurrent nerve as well as the operative methods for the resulting breathing troubles have been discussed.

(2) A bloodless method has been described.

(3) Case histories have been given in proof of the efficiency of this method.

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## CONTRIBUTIONS TO FUNCTIONAL PATHOLOGY OF THE EAR—III

### CLINICAL BEARING OF DIFFERENTIATION BETWEEN SENSITIVITY AND EFFICIENCY OF THE EAR, WITH SPECIAL REFERENCE TO VESTIBULAR TONUS

By F KOBRAK (London)

DISCRIMINATION between sensitivity and efficiency in clinical routine work might readily be dismissed as hair-splitting doctrinarism. Apart, however, from demands of scientific research, differentiation of the principles of sensitivity and efficiency is needed to avoid unnecessary controversy or misunderstanding, e.g., in a discussion on audiometry, opened by Ewing, the writer's view, that tuning fork tests should not be given up in spite of the advantages of audiometry, was rejected by Ewing, who argued that no physicist who wishes to obtain correct figures of tone intensity would prefer the tuning forks to audiometry. Such an argument justifiable from the point of view of the physicist, but not from that of the physiologist is based on the consideration of sensitivity only, not of efficiency. "Auditory lag", such as mentioned by Mollison, and by Jobson, cannot be explained unless we take auditory efficiency into account as well as puretone sensitivity. But even the basic physiological reflexions, discussed in the former paper, do not fully hold good in view of the more complicated contingencies of applied physiology in clinical otology, which are the subject of this paper. It will deal only with auditory sensitivity and efficiency, and with vestibular efficiency, not with vestibular sensitivity, the clinical knowledge of which is too vague, and not worth discussing.

#### I Sensitivity

##### AUDITORY \*

Diagnosis of auditory sensitivity is mostly based on the different types of audiometric air conduction curves, with the well known differences in low and high scale hearing. This often holds good in cases of suppurative otitis media penetrating the internal ear. The identification of high scale hearing deficiency with otitis interna is well justified, when the basal cochlea is first and foremost afflicted. However, the basal part of cochlea is not always the favourite place

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\* Including Clinical Records A B C and Notes (1) (2) (3)

of pathological change in cases, e.g. of progressive congenital deafness or of otitis interna following an invasion of toxins or micro-organisms *viâ* the blood vessels. High scale hardness of hearing, therefore, is, *a priori*, not expected to be the only type of cochlear deafness.

The purpose of audiometry in cochlear disease is not so much, as it was formerly when using tuning forks, the gross differentiation between low and high scale deafness, but rather the more detailed localization of the most affected site in the organ of Corti.

*Hypoacusis.* Our diagnosis is mostly related to hyponormal auditory sensitivity. Audiometry, the outstanding present day method of auditory test, is based on the hypothesis that each pitch of the audiometer corresponds systematically to a certain place in the cochlea, in other words that the place theory, the modified Helmholtz's theory, is illustrated by an accurate method of testing. This tacitly admitted working hypothesis, however, does not hold good in all cases of cochlear abnormality, because not all positions in the organ of Corti are equally exposed, or vulnerable, to those noxious agents which are spreading over the cochlea. - The place in the organ of Corti, identified as the clinical seat of the abnormal phenomenon, is not necessarily the only seat of actual invasion by the noxious agent, but rather the favourite site for symptomatic changes at local points of hypervulnerability (*vide* Clinical Record A, Case I, left ear), or at a certain range of hypervulnerability, such as it seems to be with the whole high scale in classical cases of cochlear deafness. (The clinical picture is shaped by intrinsic, and by extrinsic, conditions.)

This was repeatedly observed (*vide* Clinical Records B) in cases of of typical otosclerosis, sometimes with acute, even transient deterioration at the *weak spots* of the organ of Corti, such as 1024, 4096 d.v. (Records B (2) or (1) respectively). Such acute changes give an illustration, and explanation, of what occurs, specifically at least in a certain group of cases of otosclerosis, which present both typical otosclerotic middle-ear signs, as to Rinne and Schwabach, and specific features of abnormal cochlear sensitivity, with regard to the air conduction curve. These cases can be briefly called: *Cochlear Otosclerosis*. They are suggestive of otosclerotic osseous changes around the cochlea, but not necessarily, according to the occasional transience of the phenomenon, within the cochlea, that means not following definite penetration of osseous changes into the cochlea.

The explanation of hypervulnerability is based on two factors, (a) specific vascularization, (b) specific hypersensitivity (normal), and vulnerability (abnormal) in circumscribed districts of the organ of Corti.

(a) The area corresponding to 4096 cycles is relatively poorly supplied with blood (Crow *et al*). This provides a reasonable explanation in many cases of the much discussed dip at 4096, which may often

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be a response only to specific local vulnerability (Langenbeck *Zeitschr. Hals etc Heilk*, 1936), such as e.g. to irritations resulting from the noise of lower frequencies (aeroplane) In such and similar cases the dip can be regarded as an effect of masking, without complete physical damage at an especially vulnerable site of the organ of Corti

In an air-conduction curve of cochlear deafness not only the total loss of both 4096 and 8192 can be encountered, but sometimes a hearing loss at 8192 less severe, say 55 decibels, than at 4096, say 70 decibels Taking into account that the audiometric tone intensities available are less for 8192 than for 4096, it is justifiable to assume, that in some cases the typical total loss at 4096 and 8192 might be a dip at 4096 often undetectable for methodological reasons (but still noticeable in Clinical Records B (15)-B (19) and B (1)g, left)

Also in the low scale the blood supply is poor, depending on an end-artery—arteria cochlearis propria—and, so, threatened by lack of collateral supply in any case of emergency (*Berl Klin Woch*, 1920, No 8, *Handb Neurol Ohr II*, 1928)

(b) Area 1024 d v is the site of highest sensitivity to normal auditory stimuli, and, so, obviously highly vulnerable to abnormal stimuli as well (e.g. Clinical Records B(2), B (3), B (13) Dip at 1024 was also found with cases whose tympanic membrane, malleus or incus were missing (Bekesy) This might indicate a middle ear feature, as far as an early affliction of the most vulnerable part of the internal ear could be referred to lack of protecting damping in the tympanic muscles Dip at 1024 seems to be conclusive as a sign of cochlear lesion in air conduction only, it is too frequently found in bone conduction to be diagnostic

"Middle ear features" in middle ear, and in cochlear lesions In cases of cochlear lesion, in which middle ear signs of air conduction loss are present, indicated by low tone deafness, hyponormal cochlear sensitivity, *vide sub (a)*, should be considered rather than a "middle ear catarrh" associated with a cochlear lesion—a vague term indeed (This is quite apart from middle ear factors on bone conduction—"physiological negative Rinne"—attributed to hyperactivity in the tympanic muscles following irritation in the internal ear—*vide Note(7)* )

In any case, the contingent middle ear factors of cochlear deafness are a real difficulty in the accurate diagnosis of abnormal cochlear sensitivity The elimination or clarification of the 'middle ear error' is important, for a correct estimation of the scale of abnormality in cochlear sensitivity Our routine diagnostic procedure may often succeed in disentangling the mixed middle ear and internal ear signs but often fails, especially in view of the fact that the two conditions are not merely casually both present, but are causally related, shown in the "physiological negative Rinne"

It would be possible to measure the Cochlear Sensitivity directly by a method which overcomes the acoustic barrier of the middle ear in pathological cases. For this purpose the test of "minimum period of definite tonal quality" was suggested. The test depends not on the usual thresholds of tone intensities, but of tonal periods. Graduated periods of acoustic stimulation could be obtained by using, following Suggit's suggestion, a variable time control switch, which automatically cuts out the audiometer tone after the required interval.

The idea of the test is a twofold one :

First, the tone is set above the incidental intensity threshold used in routine audiometry, in order to overcome the eventual middle-ear barrier of hearing caused by middle-ear changes. This is likely to be more correct than the direct approach to the internal ear with Schwabach's test and its intricacies of bone conduction.

Secondly, the test is, on the whole, nearer than the thresholds tests, to the intensity of every day acoustic stimulation, using a stimulus of ca 50 db, although the threshold intensity would be well below 50 db.

(The particular difficulties of the test cannot be described in detail. Amongst others, a certain amount of muscular damping, i.e. an auditory efficiency factor, may arise and obscure the characteristics of a test of pure tone sensitivity.)

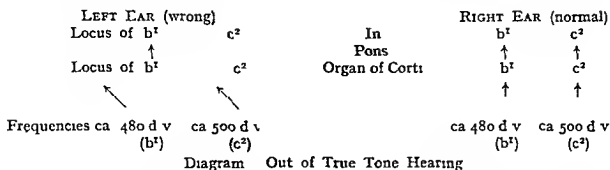
*Dysacusis.* Apart from primary, more or less circumscribed, lesions in the organ of Corti, there are secondary lesions which impair the sensitivity of the organ of Corti due to quantitative or qualitative changes in the endolymph, abnormal pressure or physico-chemical changes. In this more or less generalized involvement of the organ of Corti, conditions not only of hypoacusis, but also of dysacusis may arise. Labyrinthine hydrops with serous labyrinthitis, or of neural origin such as in certain cases of Ménière's syndrome (similar to type Hallpike) produce a hypernormal tension of the basilar membrane. The effect on the cochlear sensitivity of the hypertension depends, amongst others, on two factors :

(1) The tone can be shifted, as a whole, to a higher scale with consequent defects in hearing at the lowest part of the scale. This, otherwise specific sign of middle-ear deafness, was shown in cases of labyrinthitis serosa with tuberculosis or scarlatina upon clinical and p.m. examination (Herzog, Zange).

(2) The increased tension of the basilar membrane can cause a more complicated change in individual tones.

The explanation may be exemplified with a specific site in the cochlea : e.g. area  $b^1$ , left ear, is assumed to respond, peripherally in the organ of Corti due to hypertension of the membrane, to the frequency of  $c^2$  ; but peripheral  $b^1$ , left, is connected with, and controlled by, the central pontine area of  $b^1$ . The frequency of  $c^2$  is, therefore, centrally misinterpreted as  $b^1$ . The misinterpretation would not occur, if both ears were peripherally afflicted on the same basis and on the same scale. But  $c^2$ , left, is heard flat by a semitone, if the right ear's tone is normal and able to control the difference between both sides. (*Vide* Diagram ; Clinical Record A ; Note 1.)

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Out of true tone hearing, or musical dysacusis of any type, is an ailment of musical people. It can be regarded as a special type of abnormal auditory sensitivity in its specific relation, not to intensity, but to frequency of tone.

**Hyperacusis** Apart from hypoacusis and dysacusis, hyperacusis is often complained of, but rarely objectively confirmed. In one case of initial otosclerosis (Clinical Records D, No. 9) hypernormal sensitivity, which gradually deteriorated during a period of more than a year, was observed beyond any doubt. Other cases were highly suggestive of objective hypernormal auditory sensitivity, but could not be satisfactorily followed up like the former case.

The existence of genuine hyperacusis is worth considering in cases of Paracusis Willisii (Clinical Record C, Note (2)).

## II Efficiency

### (1) AUDITORY \*

The pure tone audiogram is generally regarded as a solid basis for diagnosis of deafness without due consideration whether pure tone audiometry, as a test of sensitivity, illustrates satisfactorily, what really matters: the hearing of the varying sounds of everyday life, i.e. auditory efficiency. The problems of auditory efficiency, although of necessity based on estimation as accurate as possible of pure sensitivity, are quite different from those of sensitivity. The following items are, amongst others, of significance.

(1) The structural factors of hearing (*J. Laryng and Otol*, lxx, 5) could be investigated by estimation of timbre. However such a test depending on special musical endowment or training, would be of no use for routine purposes.

(2) The factor of speed in hearing in regard to efficiency is not identified by the estimation of the "minimum period of definite tonal quality" but by the estimation of the auditory ability to prevent confusion of subsequent tonal stimuli. This seems to be brought about, apart from damping in the tympanic muscles (*Proc. roy. Soc. Med.*, Sect. Otol., March, 1942), by the time of decay of the excitation of a single tone.

\* Including Notes (7) and (8)



The figure 0.14 seconds of time of decay (Békésy in Stevens-Davis textbook, p. 220) applies to normal hearing. In the early stages of degenerative cochlear changes, when some hypersensitivity heralds the approach of auditory deficiency, it can well be realized that the tonal stop mechanism of normal decay is impaired with resulting confusion of subsequent tones, i.e. with resulting lack of auditory efficiency (Jobson's lag), although the audiometric figures of pure tone sensitivity appear still to be normal.

Standard gramophone records, already used in auditory tests, could be devised for the specific estimation of the maximum speed at which sentences, words, numbers, or composition of nonsense syllables could be clearly identified.

(3) The excitation that is produced by *periods of acoustic stimulation*, which vary in degree and duration, such as occurs in speech, are not demonstrated in audiograms of pure tone threshold sensitivity, whereas some information is given by the diminuendo periods of the often numerous steps of the tuning forks' steppage tests (*J. Laryng. and Otol.*, lv, 9). Not rarely, the first period alone provides a useful test to get brief information on the earliest stages of auditory deficiency.

(4) The surrounding *acoustic milieu*. The difference between sensitivity and efficiency is hardly better shown than in our efforts to have a good audiometric test in a room as sound proof and as resonance proof as possible. Arrangements, however, for ideal sound and resonance proof rooms, though providing conditions of ideal sensitivity, lose contact with reality, i.e. auditory efficiency.

Whereas the noise factor can be given a certain quantitative value expressed in decibels, the determination of the other milieu factor, resonance, is vague with regard to specific effects on hearing. Again, factors of damping may interfere, possibly, in a different way, e.g. with classical otosclerosis or with degenerative cochlear deafness: hearing of otosclerotics is not infrequently especially impaired in large rooms, such as churches, theatres, halls.

(5) *Average figures of "Hearing Capacity."* The characteristics of hearing sensitivity, the exact and specific figures of dips and crests: the air conduction audiogram is the basis to provide less accurate but nevertheless most useful information of the average figures of hearing efficiency—hearing capacity. Changes of hearing efficiency in the course of progressive congenital deafness are for the most part well characterized by *en bloc* figures of audiometry, which are obtained by summation of the decibel losses divided by the number of pitches tested.

The resulting "audiometric index of deafness" is obviously a symbol of the average of *en bloc* capacity of hearing. *En bloc* capacity is an illustration of efficiency, in which, according to our definition, several constituent sensitivities are concerned. Individual sensitivities can substitute each other by the way of "compensation" in structural hearing and, so, lose their specific significance of sensitivity. Calculation of "en bloc capacity" and the "auditory index of deafness" is based on the mutual substitution of individual sensitivities.

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## (2) VESTIBULAR.—VESTIBULAR TONUS.\*

Vestibular efficiency depends on a smooth transience from vestibular tonus at rest to vestibular tonus in activity (on movement). The resistance power of vestibular tonus at rest against movement is different, according to the difference of the main functional characteristics of the muscles concerned. The more purely *voluntary* the activity of the muscles, the more auto-tone of muscular activity comes to the fore, depending on mid-brain, cerebellar or cortical function, the less influence of vestibular reflex tonus can be expected in the muscular tone on the whole. (Example: Upper extremities.)

*Half voluntary*, or automatic, movements are obviously controlled by both the vestibular reflex tone and the auto-tone of muscular activity. (Examples: Lower extremities; or trunk; or eyes following the lines of a book—"optical nystagmus at reading"—, or following a moving object—classical optical, railway, nystagmus—, or following an acoustic stimulus.)

The conditions, however, are quite different in *involuntary reflex* movements of the eye: in vestibular nystagmus with vestibular reflexes in full operation.

Therefore, no gross delay can be expected in optical semi-voluntary nystagmus in the interrelation between the resistance power of vestibular tonus at rest and vestibular tonus on free directional movement, as natural physiological conditions upon adequate natural stimuli are in operation. But it can be expected in vestibular reflex nystagmus under experimental physiological conditions following inadequate—caloric—stimulation, if the inadequate stimulus is too small and inferior to the resistance power of the tonus at rest. It is therefore not surprising, that, by an analysis of the pre-stages and initial stages of vestibular nystagmus, following minimal caloric stimulation, certain phenomena are encountered which can be understood as a split in the dual mechanism of vestibular tonus.

This may wrongly be dismissed as "functional". It should not be, because it can do injustice to the complaints of certain neurotics, especially in legal cases, according to repeated experiences of the writer. This dual mechanism reminds us of the general principle of duality in the central control of co-operation in contraction and relaxation of unstriated muscles.

There is some evidence of a split in the dual vestibular function: inhibitory tonus at rest against disinhibitory tonus at activity.

Evidence is provided by cases in which only slight nystagmus occurs following minimal caloric stimuli, with strong response following, even slight, rotatory stimuli, such as two rotations briefly, by cases in

\* Including Clinical Records D, E, F; Notes (4), (5), (6), (7).

which it is most difficult to produce a minimal caloric nystagmus, but surprisingly easy to obtain a post-rotatory nystagmus: "*Discrepancy of Nystagmus*," viz. following minimal calorization, or rotation respectively. Once the barrier of tonus at rest is broken following rotation, then the full effect of the tonus of motion is released. This shows sometimes increased central irritability which is not rarely associated with lack of regular labyrinthine irritability, e.g. in cases of otosclerosis suggestive of pericanal osseous changes (*vide* Clinical Records D; *vide* Note 4).

A clue to a dual vestibular function is, furthermore, suspected in certain "voluntary" eye movements which not infrequently arise following caloric, in particular, minimal caloric stimuli. They are generally dismissed as atypical movements, which prevent a proper, if any observation of nystagmus. They should be regarded rather as a typical phenomenon associated with pre-stages of nystagmus. (Clinical Records E.) The movements are not, or only exceptionally, observed following gross caloric stimuli, they are clearly observed, when the induced stimulus is sufficient to disinhibit the stop mechanism of tonus at rest, but not strong enough to release instantaneously the nystagmus, or at least only over a restricted climax period. Initial and final periods however are characterized by those irregular "voluntary" movements.

It is essential that these typical movements can be executed involuntarily under abnormal tonic conditions over a period of at least 30 seconds or longer, whereas a normal individual can produce such movements voluntarily only with the definite feeling of muscular strain and for scarcely longer than 8 or 10 seconds. (The vestibular tonus at rest is certainly backed by the tonus of visual fixation. Sometimes, therefore, these movements occur, without vestibular stimulation, when vision is blurred by Bartels' 20 Diop. glasses.)

The restlessness of the eyes, looking like visual movements: searching movements—"S.M.'s"—are really straying movements. They are independent of visual stimulation, they are easily observed when visual stimuli are excluded by covering the cornea with an opaque lid of glass.

The power of muscular tension in *static* tonus can roughly be estimated by directly testing the power of resistance against passive movement, easily applicable in the extremities, less so in the trunk, but not applicable to the eyes. Our estimation of *dynamic*, directional tonus in the muscles is more specialized, but not adequately clarified.

Directional tonus in the muscles of trunk and lower extremities is to some degree obligatorily associated with vestibular basic tonus, in man, because movements of trunk and lower extremities can never be dissociated from coincident movements of the head and so from stimulation in the vestibular apparatus. However, in the upper extremities of man, as soon as he is *homo erectus*, dynamic muscular tonus is not obligatorily interlocked with vestibular basic tonus, in contrast to the quadrupedal infant or animal.

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## *The Non-conformity of Directional Tonus in the Different Muscular Groups*

An approximate estimation of the dynamic directional tonus shows, an analogy in all of the different muscular groups according to the results of gross vestibular stimulation, such as the usual 10 rotations in 20 seconds or gross calorization with 100 or more c c of cold water. In contrast to the effect of the gross shock-like stimuli of experimental physiology which disturb the conditions of natural physiology, the minimal caloric irritations resemble the magnitude of those which occur in normal physiological conditions. Following *minimal* caloric stimuli, *no parallelism* of directional tonus in the different muscular groups—trunk, extremities, eyes—has been recorded by the author. This at first came as a surprise to the observer, but on considering again the variable dependence of the different muscular groups to the vestibular apparatus, this was understandable.

Special circumstances modify the conditions of vestibular tonus

(1) Inherent (constitutional or habitual) directional tendencies  
(2) Compensatory directional tendencies (3) Lack of proportion between stimulus and effect (4) The specifically different ratio of response to vestibular tonus in the different muscular groups

(1) was fully described (1924, "Static Functions, Part II in *Beitr Anat Phys Ohr* XX) with pointing tests and Rombergism following minimal caloric stimuli. Instead of a typical response, e.g. both arms pointing to right after right cold calorization, movements of both arms inwards or outwards often occurred. It was explained as constitutional "static individuality" and might be rather called "directional individuality" since of vestibular tonus response, on a constitutional and/or habitual basis. Signs of directional individuality were noted again in recent observations on directional muscular tonus under conditions of muscular relaxation (*vide* Clinical Records F)

(2) *Compensatory (semi-voluntary) directional tendencies*

These were counteracted, as far as possible, in the investigations, mentioned sub (1), by excluding any preoccupation of the individual under test in compensatory movements.

The attitude of the trunk was controlled in the *sitting position*. As a matter of fact the sitting individual has no tendency to compensate or correct minor declinations of the trunk which not infrequently occur without the patient's knowledge if the eyes are closed. They occur without any cognizance even when the declination is of surprisingly great magnitude or though occasionally noticed without any tendency of correction.

Tendency to compensatory movement of the arms was avoided by the *Arm Pendulum Test* by which the arm is suspended in a sling the hands limp.

(3) *Lack of Proportion between Induced Vestibular Stimulus and Causal Effect*

Decrease in vestibular sensitivity can be associated with central lack of irritability, or with hyper-irritability of the neuro muscular

constituents of vestibular efficiency. Misunderstanding arising from this discrepancy can be avoided by discrimination between vestibular sensitivity and that abnormal vestibular efficiency which was found and named by the writer: Nystagmusbereitschaft (1918) (*J. Laryng. and Otol.*, 1943, lviii, 167) = Nystagmus susceptibility, partly identical with Hallpike's "directional preponderance".

## (4) *Different Ratio of Response to Vestibular Tonus in the different Muscular Groups.*

(i) *The vestibular tonus in the eye muscles.* Many variations in smooth and proportional co-operation between magnitude of vestibular stimulus and muscular effect in the eyeballs are understandable, if we consider the accuracy needed between the numerous constituents of the central vestibular clockwork mechanism which operates for the vestibular muscular tonus of efficiency, indicated in the balance of nystagmus movements.

The *central station* of normal vestibular function possesses its "*local pathways*" to the muscles of the eyes and ears. It secures "*through pathways*" to far distant muscular centres. In abnormal conditions, order of vestibular function in the central station is lacking, due to cerebral lesions or to changes in the vestibular centre following labyrinthine lesions. The conditions are no less abnormal, when the vestibular centre is subjected to induced stimuli, in particular to maximal stimuli: shock-like caloric or rotatory stimuli of practically paralysing effect in the vestibular centres. Smooth and subtle control of the vestibular switchboard is indispensable for the central station and the local pathways. For the through pathways, however, this control is the less important, the more the superior centres in the cerebellum, in the mid-brain, and in the cortex cerebri take over.

The delicacy of the vestibular mechanism with its clockwork precision at the central station and the local pathways can be analysed only by, at least quantitatively, fairly adequate stimuli, such as minimal caloric stimuli. Exposed to shocklike stimuli, the clockwork cannot control the subtle details of co-operation. What *remains*, after being more

## DIAGRAM OF THE CLOCKWORK MECHANISM OF VESTIBULAR MUSCULAR TONUS\*

\* The diagram is not the pattern obtained or obtainable by rigid records of one case, but an ideal mosaic composed out of several cases, or out of one case tested at different dates (Record 7, No. 3), and didactically typified. So, the stimulus figures are graded between 2½ cc., 30° C. and 10 cc., 15° C. Sometimes, for stage (1) only 2½ cc. of 32-35° C. are needed, on the other hand for 3b not 5, but 10 cc., 25° C. or even 5 to 10 cc., 20° C.

The detailed tonus qualities at the stages (1) to (3a) are not, or less easily, observable in 3b, blurred in (4) and almost completely suppressed in (5). The factors of vestibular tonus in the eyeballs, operating on a micro-power and minutely adjusted micro-time scale, are out of order, or even entirely out of action, when overpowered and paralysed by gross stimuli of more than physiological magnitude, i.e., shock effect.

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Stimulus of graduated intensities at columns (1), (2), (3), etc	Minimal Caloric stimulus of curca *				Gross Caloric Stimulus of 100 or more cc 25-20° C
	2½ cc 30° C to 5 cc 25° C re/1-3a		25° 5 cc		
	(1) Sub threshold with regard to excitability of whole vestibular labyrinth	(2) Sub threshold as to tonus on movement, above threshold, as to tonus at rest	(3a) Just above threshold in regard to whole labyrinth	(3b) Above threshold (<3a) in regard to whole labyrinth	(4) Well above threshold
					(5) Gross caloric stimulus
	Stages of Pre-nystagmus				Stages of Nystagmus
	Stages of non directional tonus re/1 and 2		Stage of directional tonus re/3b-5		
	(1) Central Ionization (due to central summation of stimuli, which are in each of the labyrinths separately of sub threshold magnitude), causing Nystagmus susceptibility (Nystagmus-beretschaft)	(2) 'S M's' (Searching movements, straying movements), semi-voluntary unrest of the eyeballs	(3a) Slow Component of extremely long duration with rare quick components. Deviation of both eyeballs abnormally of one eyeball = vestibular strabismus	(3b) Initial and final stages identical to (3a), however, with climax of response, say 30-75 seconds, transience to rhythmic nystagmus, with quick component often following, hesitatingly, the slow component only	(4) Definite Rhythmical Nystagmus, readily successive and quick component during most of the period of Nystagmus
Effect upon observation of the eyeballs in relaxed mid position behind Bartels' 20 Drop glasses					(5) Strong Rhythmical Nystagmus without any notable introductory phases (Sleep ascent, sleep descent curve) Easy record of endpoint of Nystagmus

or less deprived of the graduated varieties of the tonic influence, is only a rough outline of muscular response to vestibular *sensitivity*. And so, the gross stimulus test, providing not much more than the framework of vestibular reflex, proves to be a useful and reliable test of vestibular sensitivity, but loses more or less its qualities as a conclusive test of efficiency, of fine vestibular tonus. In contrast, the minimal caloric test is able to record the manifold interferences of the complicated details of tonus responses, but is not reliable as a quantitative test of vestibular sensitivity.

The steep ascent and descent of the nystagmus curve,—periods on abscisse, magnitude on ordinate—following gross stimulation, in contrast to the slow ascent and descent following minimal stimuli and to the consequent difficulty in determining the endpoint of nystagmus (Note 6), make the gross test appear as the test of choice for estimation of vestibular sensitivity, especially when sensitivity can be expected to be abnormally low and the general inconveniences of response (giddiness, sickness) are presumably negligible. However, in the subtle diagnosis of otoneurological cases or in the analysis of the physiological laws of vestibular tonus, where the detection of minor tonus varieties is indispensable, the gross stimuli should not be used. *Strabismus*, e.g. a phenomenon of induced vestibular minimal stimulation, so far never mentioned as following gross caloric tests, may be worth investigating in its eventual relationship to certain central lesions.

In contrast to the delicacy of vestibular muscular tone in the eyes, the conditions of directional vestibular tonus in the larger muscles seem to be less delicate, vestibular influence of less significance, and, as far as existent, the response with regard to vestibular directional tonus is not analogous to the directional tonus in the eyeballs, as *a priori* would be expected, considering the law of directional parallelism of the slow component of nystagmus, of fall or pointing, following gross vestibular stimuli.

(ii) *The part of Vestibular Tonus in Diverse Muscular Groups.* Spontaneous directional tendencies of diverse muscular groups—in relaxation—were compared with directional tendencies arising following minimal vestibular stimuli. The minimal vestibular stimulation in the tests of arms was mainly: slight rotations of the head; in the tests of trunk and eyes; caloric minimal stimulation. (Clinical Records F.)

This much can be said: At subjective rest, there is real objective rest, almost regularly (except in the rare case of spontaneous "S.M.'s") with the eyes, when observed macroscopically; more frequently a state of rest than unrest in the trunk; and more frequently a state of objective unrest than rest in the arms.

The objective unrest of the arms, at subjective rest, is either isodirectional, i.e. in both arms towards the same direction, or of directional convergence or divergence (inwards or outwards tonus respectively) or the unrest is sometimes alone or additionally oscillatory around the

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basic position of objective rest. (The lower extremities, the behaviour of which may be different from that of the arms, possibly more similar to that of the trunk, have so far not been investigated)

The scale of objective rest/unrest, under conditions of subjective rest, is given in diagram (a)

DIAGRAM (a) of Directional Tonus at Spontaneity (subjective rest)

Muscular Group	Objective Rest	Objective Unrest
Eyes	(practically) complete	(negligible)
Trunk	REST	unrest
Arms	rest	UNREST

A fairly analogous scale can be noted following minimal caloric, or rotatory, stimuli, in diagram (b).

DIAGRAM (b) of Directional Tonus upon Minimal Vestibular Stimuli\*

Muscular Group	Specifically Directional	Unspecifically† Directional
Eyes	(practically) complete	(negligible)
Trunk	SPECIFICALLY	unspecifically†
Arms	(negligible)	most UNSPECIFICALLY

\* The eyes were tested by minimal caloric stimuli, the trunk as well, the arms partly by minimal caloric stimuli, but mostly by rotatory stimuli. The latter consisted of slight rotations of the head to the right, to the left, forwards and backwards. These rotatory stimuli are similar to the physiological rotation of the head towards the source of an acoustic (or visual) stimulus,—i.e. without exclusion of possibly co-operating collar reflexes (Clinical Record F)

† The term "unspecific," in the diagram, applies to the phenomenon, that an effect of vestibular central tonization can be obtained, as mentioned above, *without directional specificity* which originates from the *peripheral* stimulus in the labyrinth (e.g. right cold calorization—directional tonization to right), but rather with directional tonization and manifestation of an abnormal directional tendency which, *centrally*, is already in *latent* existence. This means that, in such a case, trunk or head or arms show no, or possibly only a slight or uncertain, declination, e.g., to right, spontaneously, but more definite declination, following cold minimal calorization not only in the right but also left ear, or upon head rotation both to right and left, i.e., independently of the specific directional quality expected from the labyrinthine stimulation.

The approximate parallelism in the scale of spontaneous behaviour and of response to minimal vestibular stimuli, shown in the diagrams (a) and (b) respectively, is suggestive of the vestibular apparatus controlling the directional tonus in the eyes completely (in the "local pathways"), in the trunk to a great extent, in the arms only to a small extent (in the "through pathways").

The definite dependence of the eyes, the irregular dependence of the trunk, the quasi-independence of the arms from vestibular directional tonus cannot apply to the case of the still quadrupedal infant. During the first weeks or months



of life vestibular reflexes may play a similar rôle as the collar reflexes, which are specifically directional in the newborn and decrease during the first period of life. They are lost in the adult, except under pathological conditions, such as following a stroke (A. Simons). "Handling" originating from a "directional" reflex movement of the young infant becomes an autonomous "directive" action in man, closely associated with voluntary directional tendencies, and with vision.

It appears unjustifiable, having regard to the different vestibular influence on eye muscles on the one hand, and on trunk and arm muscles on the other, that vestibular directional analogy between these different muscular groups should be accepted more or less with enthusiasm, in spite of the diagnostic setbacks obtained by every otologist. After numerous setbacks the writer, who could not share the then uncontested enthusiasm, came to the conclusion (1924, Static Functions II), especially with regard to the phenomenon of nystagmus susceptibility (= "Nystagmus Bereitschaft") and to the analogous phenomena of directional susceptibility in Rombergism and pointing tests ("Fall Bereitschaft" and "Zeige Bereitschaft" respectively):—

The directional tendencies of eyes, arms and trunk, following induced vestibular stimuli, cannot be forced into one rigid scheme, dependent on only one factor, the directional power of vestibular reflex. In regard to the results of new investigations discussed in this paper and in accordance with the conclusion reached 20 years ago, I am bound to say: Vestibular efficiency tests should generally be restricted to the eyes. Rombergism and pointing or other arm tests should be done only in special cases, and interpreted with due criticism.

### Conclusions

The differentiation between sensitivity and efficiency in the auditory and vestibular sense is of value both to the scientist and the practising otologist. Auditory tests of sensitivity—audiometry—and of efficiency—e.g. provocative tests—are available, and so are vestibular tests of efficiency, whereas routine direct tests of vestibular sensitivity are lacking.

Tests of sensitivity are more accurate. Tests of efficiency, though of inferior accuracy, are valuable because of their response to lesser functional abnormality and even latent pathological change, in particular latent congenital hearing defects.

Sensitivity tests need the accuracy of laboratory facilities. The test of auditory sensitivity, audiometry, to give really accurate results, needs a sound proof room. Direct tests of vestibular sensitivity, so far lacking but suggested by the writer, need laboratory accuracy. The best expedient of a test of vestibular sensitivity, Hallpike's test needs the collaboration of observer and assistants, and, to satisfy to some extent the demands of a test of vestibular tonus, a well attended apparatus of irrigation.

In contrast to sensitivity tests, efficiency tests are easily done in the consulting room. The writer's audiometric provocative test, although

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a sound proof room is preferable can compare figures obtained in a fairly quiet consulting room with those obtained in experimental noise The minimal caloric tests can be carried out without any assistance or special contrivances, by using a syringe of 10 or 20 c c, water of 20-25° C., and 20 Diop glasses

The laboratory tests of hearing sensitivity are accurate but alien to routine auditory conditions The tests of hearing efficiency are less accurate, but reflect to some degree the conditions of every day hearing

The vestibular efficiency tests are essentially tests of vestibular tonus but only if minimal vestibular stimuli are used, that is stimuli which excite without paralysing

There is nonconformity of directional vestibular tonus in the different muscular groups following induced minimal vestibular stimuli, compared with the well known conformity following either shock stimuli, which practically paralyses or labyrinthine destruction, which eliminates vestibular function

The paper is a result of clinical and research work since 1902, and is especially based on observations at the Ear Department of the University College Hospital in London, since 1938 I am much indebted to the Honorary Staff for the facilities afforded and for the use of the cases of the clinics

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## Clinical Records and Comments

### (A) OUT OF TRUE TONE HEARING.

- (1) W Fred, 36 miner Head injury several years ago Right ear permanently deaf since accident Attacks of giddiness falling to left, and deterioration of hearing started some time after the accident The attacks are often heralded before any increase of deafness is noticed by *hearing out of true tone* which this musical patient volunteered spontaneously and estimated at quarter or

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half tone. Recovered hearing (left) at an interval between attacks, the last attack 5 weeks ago. Loss of hearing in decibels.

Frequencies	64	128	256	512	1024	2048	4096	8192	audiom. index of deafness
Right ear	57	75	75	79	78	68	67	68	→ 567/8=71
Left ear	38	40	30	30	45	27	52	34	→ 296/8=37

(2) W. Frederick, 52. Right ear bad 35 years. Left ear started 3 years ago; 3 months ago noticed *out of tone*, when piano playing, and steam rushing left. 20 years ago first giddiness attack; going round, vomiting. Since; four giddiness attacks. Not sure, that one of the four attacks coincided with the period of out of tone hearing. Audiometric index of deafness: \* Right 520/.6=87; Left 366/6.. =61.

(3) S. Graham, 56, artist. As ten year child first severe headache, each month. Type of attacks altered last 20 years. Instead of headache, sensation of staggering and rotation, lasting about 20 minutes, then deep sleep, awoke without giddiness. Later, deafness was associated with the attacks. The attacks were then usually heralded (in some analogy to Case 1) by "*out of tone*" or "*distorted*" hearing, or by "extra-oscillations" similar to the tone of an incorrectly adjusted wireless set. After ten days to a fortnight, stage of "distortion" ceases, and deafness starts, which usually lasts 8 to 10 days. The patient attended the clinic, because the last attack, i.e. the deafness did not disappear, now for 3 months. In 1935 lumbar puncture negative to Lues.

The case is not only interesting as dysacusis, but also with regard to the pathogenesis of certain types of Ménière's syndrome, which the writer has described as Octavuscrisis. The gradual transience from typical migraine to more or less typical labyrinthine symptoms is suggestive of the lesion (anæmia and/or œdema) moving from central to more peripheral areas. (Cf. *re* Dysacusis, Note I.)

### (B) COCHLEAR OTOSCLEROSIS.

*Cases of circumscribed Intrinsic Vulnerability of the organ of Corti to a diffusing noxious agent, with Otosclerosis.*

Amongst 93 unselected cases of congenital deafness, during the period January, 1943-1944 inclusive, there were 14 cases of Cochlear Otosclerosis, 40 of other Otosclerosis, the rest extremely advanced or atypical. All of 14 cases and another four (No. 15-18), had a more or less typical Rinne and Schwabach.

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\* Vide *J. Laryng. and Otol.*, lviii, 11, 439.

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(1) A. Horace, 30. Tests of February, 40; and December, 42. Then, after 5.9.43, when extensive lumbar puncture was done. The audiometric figures of air conduction loss are given in decibels.

Date	Frequencies	64	128	256	512/1024	2048	4096	8192
(a) 27.2 40	Right ear	30	35	35	35/40	50	62	68
(b) 15 12 42		47	47	55	53/64	60	78	66
(c) 28 9 43		48	53	57	60/65	62	82	x
(d) 8 10 43		42	49	49	51/66	64	77	x
(e) 5 11 43		47	53	54	57/66	57	53	x
(f) 31 12 43		44	52	57	55/60	57	81	x
(g) 13 6 44		48	52	52	52/66	64	60	x
Date	Frequencies	64	128	256	512/1024	2048	4096	8192
(a) 27.2 40.	Left ear	40	45	45	55/50	55	55	55(?)
(b) 15 12 42		55	59	62	68/64	75	92	68
(c) 28 9 43		58	63	67	71/72	77	85	x
(d) 8 10 43		57	62	65	67/62	60	72	x
(e) 5 11 43		54	60	59	67/61	74	84	x
(f) 31 12 43		45	58	62	69/65	82	92	x
(g) 13 6 44		58	61	76	77/99	87	65	62

After typical high scale deafness sub (a) and (b), varying figures are noticeable from (c) to (g), left mostly in the circumscribed areas of 1024 and 4096, right at 4096. The left ear shows, furthermore, a significant "compensation" between pitches 1024 and 4096 sub (e) and (f) against (g).

(2) H. Lillian, 43

Frequencies	64	128	256	512/1024	2048	4096	8192
18 2 44 Right	57	65	70	77/77	72	63	57
13 6 44 Left	60	73	72	75/91	72	62	56

(3) W. Charles, 56.

Right	57	64	54	65/66	98	95	70
Frequencies				1024		4096	
Left	37	35	34	39/67	51	94	70
Right	typical high scale			Left typical dip at 1024 (and 4096?)			
X rays	typical otosclerotic changes in the petrous bone						

(4) P. Violet, 54.

Right	60	75	74	98/100	100	85	70
Left	x	x	90(?)	x/x	x	x	x
Bone Conduction (fork c) right not shortened, Rinne negative							

(5) D. Walter, 35

Right	53	62	65	64/72	67	95	70
Left	59	62	61	66/69	60	95	70

(6) R. Alfred, 46

Right	100	75	78	80/76	70	80	70
Left	45	50	48	51/55	44	63	70
Weber (e and a <sup>1</sup> ) to the left, Schwabach (e) +, (a <sup>1</sup> ) + o							

(7) L. Joan, 29.

Right	58	61	57	66/68	60	65	61
Left	60	67	78	78/86	84	83	70
Pat volunteered	"Hear lower notes, generally, better than high notes"						

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(8) B. Jessie, 21.

Right	60	75	88	102/100	100	95	70
Left	51	55	62	68/75	57	48	47

(9) W. Priscilla, 22.

Right	60	66	71	80/81	80	95	70
Left	60	66	69	74/77	70	61	58

Right typical high scale deafness Left slight, but typical dip at 1024 (decibel loss 77).

(10) R. Edith, 34.

Right	60	75	80	87/97	99	95	70
Left	60	67	67	73/78	78	75	70

(11) F. Robert, 51.

Right	60	70	78	82/85	75	95	70
Left	60	74	82	87/98	100	95	70

(12) R. Alfred, 58.

Right	80	75	79	84/91	96	95	70
Left	x	x	x	105/110	x	x	x

Paradoxically, one of the two pitches still audible left ear, is, here, the most vulnerable, 1024 (decibel loss 110).

(13) E. Mabel, 31.

Frequencies				1024			
Right	34	37	39	39/54	22	29	35
Frequencies				1024		4096	
Left	53	61	62	61/78	53	61	42

Right dip at 1024 Left at 1024 and 4096

(14) G. Leo, 22.

Frequencies					4096	8192	
Right	57	65	67	66/65	57	92	70
Frequencies					4096	8192	
Left	57	63	66	67/67	56	93	70

Appears to be typical high scale deafness However, possibly, dip at 4096, which might be detected, if higher tone intensity at 8192, say 80 or 85 decibels, were available. This refers to the following four cases (15-18).

(15-18) Out of a set of some 50 earlier cases of Cochlear Otosclerosis, 4 show, at 8192, still less loss of decibels, than at 4096; this is suspected to be a *pre-stage of complete high scale deafness*.

(15) F. HILDA, 32.

Frequencies	64	—	—	—	2048	4096	8192
Right	42	—	—	—	55	47	37
Frequencies	64	—	—	—	2048	4096	8192
Left	46	—	—	—	37	68	54

12 2048 right, vide comment Case 17

(16) G. Andrée, 18.

Frequencies	64	—	—	—	2048	4096	8192
Right	22	—	—	—	18	65	48
Frequencies	64	—	—	—	2048	4096	8192
Left	32	—	—	—	72	79	70

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(17) W. Delis, 31.

Frequencies	64	—	—	—	2048	4096	8192
Right	48	—	—	—	70	48	42

Special vulnerability of pitch 2048, instead of 4096 (Case 17) occurs occasionally. Mostly, 2048 is the least vulnerable pitch of the high scale. His relative (18) has typical dip at 4096

(18) B. Clifton, 44; relative of (17).

Frequencies	64	—	—	—	2048	4096	8192
Right	45	—	—	—	50	74	48

(B special case). D. Henry, 63. Non-otosclerotic cochlear deafness with 8192 better than 4096.

Frequencies	64	—	—	—	—	4096	8192
Right	43	—	—	—	—	73	59
Frequencies	64	—	—	—	—	4096	8192
Left	57	—	—	—	—	75	57

(C) HYPERACUSIS IN NOISE, produced by the *Bárány Box*.

The following figures of Air and Bone Conduction represent the *difference* of hearing not exposed, and exposed, to noise. The not exposed hearing provides the basic (zero) values against exposed hearing.—The last 150 provocative tests (September, '42-February, '44) are considered here. Mostly, cases with more than one plus figure were employed.

(1) K. Robert, 64. Grippe neuritis VIIIth nerve.

Frequencies	64	128	256	512/1024	2048	4096	8192	correspondent
Right Air C	-17	-15	-17	-12/-8	+8	+3	+7	behaviour of
Bone C	?/? < -0	-9	-16/-20	-11 (-10)	?/?			Air and Bone
								Conduction

(2) P. Elsie, 32. Ménière's syndrome left.

Left Air C	< -0	-5	-8	-6/+2	+1	+1	+3	inverse
Bone C	?/? < -3	-18	-27/-28	-34	-3	< -0		behaviour of
								Air and Bone C.

(3) P. Mabel, 46. Ménière's syndrome left.

Left Air C	± 0	+1	-10	-7/+3	+2	-2 < -0	inverse.
Bone C	< -0	< -0	< -6	-17/-26	-30	-13 < -0	

(4) Ch. Bessie, 27. Classical Otosclerosis.

Left Air C	+5	+6	± 0	-9/-12	-11	-8	-3
Bone C	-2	-9	-15	-13/-20	-12	-15	-14

(5) St. Kathe, 53. Otosclerosis.

Left Air C	+6	+13	+6	-6/?	-13	-4 < -0	
Bone C	?/? < -2	-14	-24/-20	-7	-16	?/?	

(6) W. George, 34. Otosclerosis.

Left Air C	-2	-1	+1	+7/-4	-14	-12	-6
Bone C. only "feeling"	< -6	-4/-7	-9	-20	± 0		

(7) B. Jessie, 21. Otosclerosis.

Frequencies				1024	2048			
Right Air C.	< +0	+2	+6	+3/not heard	± 0	×		inverse ?
Bone C.	-8	-15	-11	-21/-7	-11 < -8	< -1		

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## (8) B. Jessie, 21.

Right	60	75	88	102/100	100	95	70
Left	51	55	62	68/75	57	48	47

## (9) W. Priscilla, 22.

Right	60	66	71	80/81	80	95	70
Left	60	66	69	74/77	70	61	58

Right typical high scale deafness Left slight, but typical dip at 1024 (decibel loss 77).

## (10) R. Edith, 34.

Right	60	75	80	87/97	99	95	70
Left	60	67	67	73/78	78	75	70

## (11) F. Robert, 51.

Right	60	70	78	82/85	75	95	70
Left	60	74	82	87/98	100	96	72

## (12) R. Alfred, 58.

Right	60	75	79	84/91	96	95	70
Left	x	x	x	105/110	x	x	x

Paradoxically, one of the two pitches still audible left ear, is, here, the most vulnerable 1024 (decibel loss 110).

## (13) E. Mabel, 31.

Frequencies				1024			
Right	34	37	39	39/54	22	29	35
Frequencies				1024		4096	
Left	53	61	62	64/78	53	61	42

Right dip at 1024. Left at 1024 and 4096.

## (14) G. Leo, 22.

Frequencies						4096	8192
Right	57	65	67	66/65	57	92	70
Frequencies						4096	8192
Left	57	63	66	67/67	56	93	70

Appears to be typical high scale deafness However, possibly, dip at 4096, which might be detected, if higher tone intensity at 8192, say 80 or 85 decibels, were available. This refers to the following four cases (15-18).

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Frequencies	64	—	—	—	2048	4096	8192
Right	42	—	—	—	55	47	37
Frequencies	64	—	—	—	2048	4096	8192
Left	46	—	—	—	37	68	54

11 2048 right, vide comment Case 17.

## (16) G. Andrée, 18.

Frequencies	64	—	—	—	2048	4096	8192
Right	22	—	—	—	18	65	48
Frequencies	64	—	—	—	2048	4096	8192
Left	32	—	—	—	72	79	70

# Contributions to Functional Pathology of the Ear

privilege of otosclerosis (according to 8), and objective hyperacusis neither (1, 2, 3, 9, 14). Case 8 is dating from childhood: discharge and deafness Later dry. Now, typical adhesive process.

(Cf. *re*/Hyperacusis, Note 2.)

(D) "VESTIBULAR DISCREPANCY" between *Rotatory* and minimal *Caloric* Nystagmus response.

More than 200 vestibular examinations on some 180 patients were done. Caloric and rotatory tests were done at the same date on 125 cases. Definite discrepancy was found in 15 cases, 8 of which were otosclerosis, 3 probably otosclerosis, 2 neuritis of the VIIIth nerve following influenza, 1 Ménière, 1 typical migraine, 1 cochlear deafness following gunfire, *no* case of genuine congenital cochlear deafness. The high percentage of otosclerosis points to vestibular (pericanal osseous) changes, the case of migraine to an abnormality in central tonization of the vestibular system, the case of gunfire deafness is in accordance with the writer's experience that *cochlear deafness* following exposure to *noise of high intensity* shows a typical change in the vestibular "mid-end test". The trembling and vacillating character of nystagmus (not to be mixed up with the "S.M.'s," Searching Movements) was repeatedly observed in cases of discrepancy. It is obviously a sign of central disorder in vestibular tonus following primary central changes, or secondary to peripheral vestibular lesions

(1) M. Shirley, 16, otosclerosis?

Caloric 18° 5 c c and 18° 10 c c no response,

Rotatory 2 rotat Left and Right respectively "S M's" only, 5 rotat Left 22 jerks, 5 Right 16 jerks

(2) M. James, 52, otosclerosis? with old chronic M.E. Is father of (1).

Caloric 18° 5 c c no response, 18° 10 c c poor and short response

Rotatory 2 rotat Left 17-18 fine jerks, 2 Left 19-20 fine jerks

(3) J. Edwards, 42, otosclerosis.

Caloric 20° 10 c c Right no response, Left poor response

Rotatory 2 rotat Left ca 40 jerks, 2 rotat Right ca 35 jerks

(4) B. Stephen, 15, early otosclerosis?

Caloric 20° 10 c c Right medium response (at another date poor), Left no response

Rotatory 2 rotat Left ca 32 (end position), ca 18 (mid position) jerks, 2 rotat Right ca 33 (end), ca 20 (mid)

(5) G. Leon, 22, advanced otosclerosis.

Caloric	17° 10 c c	Right almost nil, Left poor	} "inhibition" (1918), growing with increase of minimal stimulus 17° against 28°.
at another date	28° 10 c c	Right poor, Left medium	
Rotatory	5 to Left	<50 quick, small, but sharp jerks, 5 to Right <35 jerks	

(6) S. George, 32, otosclerosis.

Caloric 16½° 10 c c Right medium, Left normal

At another date 20° 5 c c Right medium, Left almost nil

Rotatory 5 to Left ca 43, to Right ca 47 jerks



(7) R. Alfred, 58, advanced otosclerosis.

Caloric 20° 5 c c Right *poor*, Left *nil*, 20° 20 c c Right medium  
Rotatory 5 to Left 45, to Right 17

(8) W. Ida, 28, typical migraine.

Caloric 20° 10 c c Right *poor*, Left *normal*  
Rotatory 2 to Left ca 16 jerks, 2 to Right ca 35 rhythmical jerks, then trembling

(9) H. Margaret, 28, early otosclerosis.

Caloric 17° 5 c c Right *nil*, 17° 10 c c Right medium, Left *nil*  
Rotatory 5 to Left (end position of eyes) 30, to Right ca 20 jerks, 5 to Left (relaxed mid position) ca 40, to Right ca 37 jerks

The first test taken a few weeks after onset of her symptoms (roaring, buzzing giddiness) extremely marked response to minimal calorization. Figures of the test above 5 months later. Another 4 months after the test above, no longer caloric/rotatory discrepancy present. *Hearing* first test better than normal. In the course of more than a year slight, but definite decrease. Audiometric indices of deafness (normal cases in our sound proof room 18-20 decibels loss) (15 1 43) Right -10, Left -12, (12 3 43) Right -18, Left -17, (25 8 43) Right -30, Left -24, (15 2 44) Right -18, Left -23. X-rays (15 2 44) "typical otosclerotic changes in the petrous bone"

(10) W. Norman, 28, cochlear deafness left after rifle explosion 16 days ago.

Caloric 20° 10 c c Right "S M's," no nystagmus  
Rotatory 2 to Left ca 23, to Right ca 27 jerks (relaxed mid position, 20 Diop glasses), 2 to Left almost *nil*, to Right ca 16 jerks (end position)  
Four weeks later interference of Nystagmus susceptibility to Right  
Caloric 21° 20 c c Right a few "S M's",, Left definite Nystagmus  
Rotatory 2 to Left ca 15 to Right ca 23 jerks (relaxed mid position), 2 to Left *nil*, to Right *nil* in end position, however after 5 rotations, 5 to Left <50, to Right ca 26 jerks in end position

(11) H. Sidney, 22, Ménière's syndrome.

Caloric 18° 5 c c both ears *poor* the same 16° 10 c c slight Nystagmus susceptibility to Right  
Rotatory 2 to Left and Right *nil*, 5 to Left ca 12, to Rt ca 14 jerks in relaxed mid position, 5 to Left <50, to Rt ca 40 jerks in end position  
Patient's mother, invited for scientific reasons extremely advanced otosclerosis  
No caloric response No rotatory response, even not to 10 rotations in 20 seconds

(12) P. Herbert, 36, right cochlear deafness due to neuritis VIIIth nerve post influenza, 4 months ago.

Caloric 15° 5 c c or 10 or 20 c c both ears *no*, or practically *no* response  
Rotatory 2 to Left uncertain, to Right 8 jerks (relaxed mid position, 20 drop glasses), 2 to Left ca 30, to Right ca 30 jerks (in end position)

(13) K. Robert, 64, left ear deafness, vertigo due to neuritis VIIIth nerve following influenza, one month ago

Caloric 16° 5 c c Right *nil*, 10 c c *nil* 20 c c "S M's", Left *nil*  
Rotatory 2 to Left ca 12, 4 to Left ca 30 jerks, to Right practically *nil*

In contrast to the former cases, there is caloric > rotatory response with the following two cases.

(14) B. Elsie, 21, otosclerosis

Caloric 22° 10 c c both ears completely *normal* response  
Rotatory : 2 to Left *nil*, 2 to Right *nil* (both in relaxed mid-position and in end-position.)

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## (15) H Agnes, 35, otosclerosis

Caloric 18° 5 c c Right and Left *strong* response with Nystagmus susceptibility to Right

Rotatory 2 to Left *nil* 2 to Right *nil* (relaxed mid position) 2 to Left ca 12 2 to Right 3 4 poor jerks (end position)

The idea of the examples is not to state a rigid scheme of figures according to which it is easy to analyse the vestibular situation. The examples are to show that the individual analysis is problematic and difficult by considering caloric or rotatory behaviour alone. The conditions however are easily clarified by deliberate consideration of the caloric rotatory nystagmus discrepancy (Cf *re* "Inhibition of Nystagmus," Note 4)

## (E) "S M's"—SEARCHING MOVEMENTS of the Eyeballs

Statistics on S M's, collected from some 200 vestibular examinations, would be tedious. The more or less high percentage is not significant, but the conclusion that the S M's should be regarded as a typical phenomenon of vestibular tonus when it is functioning abnormally. S M's are not at all infrequent after minimal vestibular stimuli, more frequent after caloric than rotatory stimuli, and more frequent as phenomenon of response alone than associated with nystagmus. In the latter case nystagmus jerks are the climax, S M's the initial and/or the final stage of the whole period of response.

## (F) COMPARISON OF DIRECTIONAL TONUS IN EYES/ARMS/TRUNK

The conditions of relaxation were as follows. *Eyes* were observed behind 20 diop glasses, i.e. with blurred vision, the *trunk* was observed in sitting position, for "*sitting Rombergism*," with the legs hanging down over the edge of the table not supported by the floor, the arms folded, the *arms* were observed suspended in a sling fixed from a gallows—"arm pendulum test."

70 out of 97 unselected cases, the majority congenital progressive deafness, a small minority Ménière's syndrome, etc. were submitted to muscular tests, some of all of the three groups—arms, trunk, and eyes—some of two, some of one group only. Vestibular normality or abnormality of our cases could bring out vestibular directional tendencies in the different muscular groups on a *quantitatively different* scale, but normality or abnormality would *not* eliminate the difference of directional tendencies *basically*. The relatively small number of 70 cases—97 on the whole, 27 inconsistent—is not sufficient to provide a rigid percentage of the differences, which to expect would be unwise with such fluid functions as the functions of tonus and especially directional tonus. The difference of vestibular influence was observed in the 70 cases mostly by rotatory tests on the arms, by caloric tests on eyes and trunk. (The

difference appears also when arms and eyes are compared, both following post-rotatory findings. These were obtained with cases not included in the 70 mentioned above. Then, in contrast to the arms, specific vestibular directional response can often be observed in the eyes, after one or more slight rotations of the head right/left, by putting the fingers gently on the closed eyes when standing behind the patient.)

The findings in the different muscular groups :

*Eyes.* Direction of the slow component of spontaneous nystagmus or of directional nystagmus susceptibility following minimal calorization were recorded.

*Arms.* Directional tendencies in "arm pendulum test" (arms suspended) *spontaneously*, and/or following *rotations* of the head to left, to right, forwards, backwards were recorded. In several cases minimal caloric stimuli were used in addition. Generally there was more or less the same "non-specific" directional response, independent of the varying directions of the rotation. This is obviously no actual directional effect peripherally, but a latent directional tendency at the centre.

*Trunk.* Directional tendencies in sitting position were recorded, spontaneously, and/or after minimal calorization. The effect was more frequently specific (e.g. Right cold causes sitting Rombergism to right) than "non-specific" such as with the arm tests (e.g. not only right, but also left cold calorization causes sitting Rombergism to right).

Directional conformity in the three muscular groups was found in only three cases. It is noteworthy that two of these cases were central lesions, the third a serious case of Ménière's syndrome, possibly following a central lesion (control tests not available).

Directional tendency in

- (a) Trunk/arms equal, 11 cases ; opposite, 10 cases ; inconclusive, i.e. unequal, in great majority.
- (b) Slow component (of nystagmus or nystagmus susceptibility) /trunk equal, 6 ; opposite, 11 ; inconclusive, i.e. unequal, in majority.
- (c) Slow component/arms equal, 7 ; opposite, 16 ; unequal, rest.

Attention is directed to the different proportion between "equals" and "opposites" sub. (a), or (b) (c) respectively. The relatively small number of observations (73) on the whole does not allow a conclusion to be drawn.

## Notes

(1) *DYSACUSIS referred to Alternation or Rotation.*

Phenomena of dysacusis must be analysed separately from, though sometimes associated with, hyposensitivity. They may be, not infrequently, encountered with certain types of Ménière's syndrome. Amongst

# Contributions to Functional Pathology of the Ear

a large series of unselected cases of deafness, our three cases of dysacusis suffered from Meniere's syndrome (*vide* Clinical Records, A)

An interesting description was volunteered by patient S Graham (Clinical Record, A, no 3) about "*distortion*" of his hearing. He compared the distortion with noises of a wireless set incorrectly adjusted to the wavelength and, so, producing "*extra oscillations*". Possibly, such or similar sensations of distortion might prove to be not quite unusual when detailed inquiries—of course by avoiding suggestive questions—would be done. Our special case of dysacusis, of incorrect adjustment of tone, as the patient's feeling was, is suggestive of abnormal labyrinthine perception of one or more individual tones. This calls to mind that bundle of fibres which serve the micro timed course of perception of one individual tone by, normally, regular *alternation* or *rotation* in successive co operation of the single fibres of the bundle. Alternation or rotation arises only with the perception of higher frequencies, above ca 900 or 1800 dv respectively (Stevens-Davis, Textbook, p 393). It would be of significance to establish, whether dysacoustic phenomena, like those mentioned, occur within the range of higher tones only, i c related only to the specific capacity of alternation or rotation.

No monaural diplacusis was found in our group of cases. It seems to be an open question, whether monaural diplacusis is in any case genuinely monaural, or possibly, "*false*" in some analogy to the psychological error in the "*false Rinne*" (Cf *re*/Dysacusis, Clinical Record, A)

## (2) OBJECTIVE HYPERSENSITIVITY—COCHLEAR SENSITIZATION—IN NOISE

Although no parallelism was found between definite subjective Paracusis Willisii, and objective audiometric paracusis in experimental noise, the data of objective paracusis are noteworthy. With several cases not only of otosclerosis but also of non-otosclerotic deafness, hearing was absolutely improved for audiometric tones in the one ear, when the other ear was exposed to the Bárány box—in the "*Provocative Tests*" (Clinical Records, C). There was (a) either, for some pitches, an absolute improvement of air conduction with deterioration of bone conduction (Clinical Records, C, 2, 3, 7, 9, 13), or (b) an absolute improvement of both air and bone conduction (Clinical Records, C, 1, 12, 15). However, bone conduction was in (b) less improved than air conduction, so that, both in (a) and (b), the hearing of bone conducted tones in noise was *relatively* worse than that of air conducted tones. This points to two effects based on partly analogous partly antagonistic co operation. The obviously dual origin of the two effects might be, on the one hand, lack of damping, partly attributable to abnormal *vestibular* response in the tympanic muscles, on the other hand, genuine hypersensitivity

in the *cochlear* nerve. Hypercritical attitude towards genuine cochlear hypersensitivity caused by noise seems to be no longer quite justified, as the following observation was sometimes made, occasionally even with patients of higher intelligence, whose answers were correct and reliable. This or that audiometer tone was heard, in the Provocative Tests, only as long as the Bárány Box operated, disappeared when the Bárány box stopped, and re-appeared when the box re-operated.

No convincing explanation of hypersensitivity in noise seems to be available. Besides changes of damping in the tympanic muscles, masking in the Corti organ must play a part in the Provocative Test. Masking depresses in the main, but might be also able to sensitize to some degree receptory cells of the sensory organ. We should expect as a rule that the depressing effect of *noise* increases proportionally more than the sensitizing effect, with increasing noise intensity, by regarding the non-linear proportion between *tone* intensity and cochlear potential following increasing tone intensity. In contrast to this rule, however, in certain conditions which are obviously associated with hyperacusis in noise, the sensitizing effect of masking seems to be greater than the depressing effect. The phenomenon, though not explained, loses the full extent of its paradox by calling to mind the "negative value of masking" (Stevens-Davis, Textbook, p. 208) of two tones which are close enough together to beat: they are apprehensible by beats, even when each of these tones is inaudible. The apprehension of these beats can be regarded as a sensitizing effect of masking. (Cf. *re*/Hyperacusis, Clinical Records, C.)

## (3) AUDIOMETRIC FIGURES OF CONSULTING *and* SOUND PROOF ROOMS.

Everyday hearing efficiency is more or less exposed to surrounding noises, and hearing, especially, in rooms, is subjected to complicated sound resonance from the walls. The noise factor of relatively high intensity and special administration was investigated by the "Provocative Test". It was shown that the effect of experimental noise can be different in a normal ear or in some cases of congenital cochlear deafness from that in cases of ordinary otosclerosis. Deduction therefore of a certain amount of decibels, without regard to the type of deafness concerned, by giving a general allowance for testing in a room with a noise of this amount of decibels, does not consider the factors just mentioned of specific efficiency, demonstrated in the provocative test, but is related only to pure tone sensitivity. Such deduction, although basically unsound, may nevertheless sometimes be admissible as a routine procedure.

## (4). "INHIBITION OF NYSTAGMUS," *especially with Neurotics (a partial phenomenon of vestibular discrepancy?)*

The rotatory response was in 13 out of 15 cases of vestibular discrepancy greater, in two cases smaller than the caloric response.

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The smaller effect of the stronger stimulus in the two cases is somewhat analogous to the not unfamiliar experience that, in the central control of the antagonism between contraction and relaxation of unstriated muscle, the stronger stimulus can bring about a greater effect on contraction than on relaxation. There is not only a close anatomical relation, but also physiological relationship between the vestibular and the vegetative nervous system. In the vestibular cases, not the type, but the presence of discrepancy is significant.

Poor caloric Nystagmus then, without comparative rotatory test, was described by the writer (in 1918, *Beitr Anat, Physiol Ohr*, etc xi) as "*inhibition of nystagmus*", in man. (Reference was made to this phenomenon by Demetriades and Spiegel (1922). They found, in rabbits, a certain lowering of blood pressure following one rotation, but decreased lowering following increased number of rotations.) In man, it is sometimes difficult to find that small range of response (minimal calorization!) which lies between inhibition—too strong a stimulus—and lack of response—too small a stimulus. This occurs mostly with neurotics, e.g. traumatic neurotics (Clinical Records, D, No 5). The barrier of inhibition can be broken, of course, by using gross stimuli, but the confidence of the patient is broken as well at the same instance. This causes, in legal cases, and so in malingering, a situation which is tense and unsatisfactory. (Cf *re*/"Vestibular Discrepancy", Clinical Records, D.)

## (5) HALLPIKE'S *Method of Calorization*

The inability of the gross caloric test to record small or medium tonus abnormalities on a reliable scale, such as those in the majority of cases of Ménière's syndrome, does not exclude its application in cases of gross abnormalities of vestibular tonus, e.g. of advanced cerebral tumors or of labyrinthine destruction. Hallpike's method may just steer a middle course between gross and minimal calorization. I have no experience of the test, which when carefully done, needs teamwork, and instruments in good order. The writer's minimal caloric test needs no assistance by using a simple by syringe of 10 or 20 c.c., and 20 diop. glasses.

## (6) PROTRACTED NYSTAGMUS *following minimal calorization*

The relatively abrupt cessation of nystagmus following gross stimuli, is in contrast to the occasionally protracted nystagmus, following minimal stimuli. Protracted nystagmus can last 180-300 seconds, and even longer. This hypertonization—in end-position—can not occur when the delicate vestibular tonus is practically paralyzed by shock stimuli, but only when it is properly elicited by minimal calorization. I cannot remember having seen such protracted nystagmus before I systematically started to use minimal calorization, some 35 years ago. Moreover, hypertonization may not occur following moderately gross stimulation, otherwise it would not have escaped the observation of Hallpike *et al*.

## (7) TONUS IN THE TYMPANIC MUSCLES + *Cochlear Sensitivity.*

### *The "Provocative Negative Rinne" and the "Physiological Negative Rinne."*

We can reasonably take for granted that vestibular tonus plays a part in the graduated activities of the tympanic muscles, using the "local pathways" from the vestibular centre. In order to prove vestibular tonus in hearing it is necessary only to prove the existence of the activities of the tympanic muscles in man. This was done, visually, by Luescher with the otomicroscope (1929). The question was again debated (1940) following findings with forks' steppage tests. Later, originating from experiments in animals (H. Kobrak *et al.*), the effect of numbing in man was observed while listening to different frequencies of the audiometer (*Proc. roy. Soc. Med.*, Sect. Otology, March, 1942). A discrepancy between air and bone conduction was found as a response to numbing. A regular, and typical, discrepancy was found again, when, instead of gross numbing (with c' tuning fork of highest intensity), mitigated numbing was carried out by the Bárány box in the "Provocative Test". The normally positive Rinne becomes negative in a normal ear which is exposed to the noise of a Bárány box applied to the other ear. The first general conclusion was: middle-ear conditions are experimentally altered by noise. The second conclusion was: as the alteration occurs immediately, specifically, and reversibly, there is no other part of the middle ear capable of all of these qualities as the tympanic muscles.

The relations between muscular function and sensory nerve sensitivity in the "Provocative Test," are similar to those in the Rinne test as far as the latter is ascribed, not to morphological changes, but to abnormal physiological conditions in the tympanic muscles (*J. Laryng. and Otol.*, 1940, iv, 9). Both the "physiological negative Rinne" with abnormal cochlear sensitivity and the "provocative test," are based on provocative factors, the "provocative Rinne" mostly on the extrinsic factor: noise, the "physiological negative Rinne" on the intrinsic provocative factor: degenerative hyperexcitability. Relationship, therefore, between provocative negative Rinne of the *normal* ear and "physiological negative Rinne" in certain cases of cochlear deafness is apprehensible. The normally negative provocative Rinne, however, becomes positive, when not only—such as in a normal case—the extrinsic factor, noise is present, but also—such as in an abnormal case—the intrinsic factor, degenerative hyperexcitability.

The positive provocative Rinne is regarded as a failure of normal damping, when the limit of tolerance against the dual assault of noise and nervous hyperexcitability is passed. On the other hand, the "physiological negative Rinne" becomes positive, when the intrinsic

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provocative stimulus of early stages of cochlear deafness is replaced by hypo excitability of the later stages

The limit of efficiency in strained reflex hyperactivity of the tympanic muscles can be passed following not only sensory nerve hyperexcitability and hyperstimulation, but also osseous changes near to the tympanic muscles, such as with otosclerosis. The *provocative test* seems therefore, to be able, according to observations on a so far limited scale, to *detect*, even latent, *pre-stages* of both types of progressive *congenital deafness*

## *Special Observations on the "Provocative Negative Rinne" and the "Physiological Negative Rinne"*

Out of a large number of unselected cases of cochlear deafness, observed during the last one and a half years, only 44 tests are conclusive. Many cases had to be excluded for actual or eventual lateralization of bone conduction, for too small residua of hearing, or for unreliable answers of the patient. The audiometric figures of the "physiological negative Rinne" can be divided in three categories: (a) Rinne negative, average 1-10 decibels, (b) 11-20 db, (c) 21-50 db. Area (a) is next to, and overlapping with, normal conditions, (b) means slight but conclusive negative Rinne, (c) definite physiological negative Rinne. These three categories are related to the respective figures of the provocative Rinne, shown in the diagram

Physiological negative Rinne	Provocative Rinne+	Provocative Rinne—
(a) 0-10 db	3	15
(b) 11-20 db	6	10
(c) <-20 db	9 (or 10)*	1 (or 0)*

The available number of cases (44) is small. However, it is noteworthy, how the figures of positive provocative Rinne increase, and accordingly of negative provocative Rinne decrease, with increasing figures of physiological negative Rinne. In cases of definite physiological negative Rinne (column (c) with <-20 db) the ratio of positive to negative provocative Rinne is 9:1, or even 10:0. That means, the more severe the intrinsic provocative stimulus in the nerve (increasing physiological negative Rinne), the more the damping activities of the tympanic muscles fail to sustain the extrinsic provocative stimulus of noise (increasing provocative positive Rinne).

Furthermore, it is noteworthy that the *provocative positive Rinne* seems to *prevail* in cases of cochlear deafness associated with *vestibular lesion* (Ménière, neuritis VIIIth nerve) in contrast to cases of provocative negative Rinne in the majority of cases of congenital cochlear deafness without vestibular lesion.

\* One of the 10 cases graded with physiological negative Rinne <-20 db had Rinne of -19½ db



## (8) COMBINED VESTIBULAR AND COCHLEAR SENSITIVITY IN MUSICAL HEARING.

Problems arise, here, which, although systematic scientific research is greatly lacking, seem to be worth investigating. Originating from rhythm, a musical phenomenon often mentioned as a vestibular function, other musical features should be considered in view of possible vestibular correlation. These musical features are characterized by stimuli of regularly repeated pure mechanical pressure, in addition to the specifically acoustic rhythmical pressure of frequency. The question of sound phase was discussed as related to the question of directional hearing (*J. Laryng. and Otol.*, lix, 5). Phases are significant also in musical hearing. Pure mechanical pressure, without specifically tonal quality, of eu-rhythmical or dys-rhythmical phase are, obviously inherent in the harmonic or dys-harmonic coincidence, respectively, of two or more tones. So, not only our primitive rhythmical, but also our finer musical sense of melodious harmony seems to be worth considering in the light of vestibular function, having regard to Helmholtz's view that our uncomfortable feeling of musical dys-harmony depends on arhythmical beats.

A subjective impression, of no scientific validity, made me think over some routine experiences of artistic musicians who are trained in the practice of music by technical methods. The subjective impression (or suggestion), repeatedly noted, is the faculty (or imagination) when listening in broadcast: to identify "forte" tones, especially of instrumental music, *qualitatively*, not quantitatively, as being of "forte character", even when the "forte intensity" of the receiving wireless set is tuned right down. The tones, which then no longer appear loud, betray nevertheless their "forte" origin. The qualitative impression is, that the "pseudo-forte" is recognizable by a sensing of resonance carrying the sound or carried by the sound. The genuine "forte" involves a function of the internal hair cells in addition to that of the external cells; the "pseudoforte" would mean a function of the vestibular apparatus in addition to that of the external hair cells of the organ of Corti, by ascribing resonance to the vestibular apparatus.

This calls to mind another observation at the final stage of the decaying tuning fork. Musical people say, at the final stage, that they no longer sense a tone, but only a particular *feeling of vibration* reminiscent of, but not representing, tonal quality. This is similar to the phenomenon perceived, when a chime of bells is fading out. (*J. Laryng. and Otol.*, lv, 9.) This is called in German "verhallen," that means sensations which are related to a hall where certain conditions of resonance exist. "Verhallen" (there is no English synonymous verb "dis-hall") means the fading out of specific acoustic phenomena associated with a hall.

Resonance "carries" a tone. It does not make the tone really louder, but full and round. It is of etymological significance, that

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"full" and "round" are *spatial* attributes of a thing\* Resonance makes the tone better qualified to be carried over a greater distance Singers, trained in the technical use of the singing voice, eager on the one hand to save their voice, on the other hand to make their voice carry as easily as possible, avoid increasing the intensity of the tones unduly This would be detrimental to their larynx (and to the ears of the audience) So, they sing "vibrato", a rhythmical pulsating accentuation of the tones The tones of string instruments can also be made fuller, greater—and, seemingly, louder—when the tones produced by the bow are not increased in intensity, but a vibrato is produced with the fingers of the left hand It is an open question, which part of the labyrinth operates as micro resonator

Some of the musical problems seem to be worth investigating in view of eventual vestibular action potentials These might play a part in experimental findings which appear to be paradoxical by considering cochlear potentials only

The general view, that sensitivity and efficiency of the vestibular apparatus has nothing to do with hearing, should be revised

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\* *Spatial* control is the basic function of the vestibular apparatus

## F. Kobrak

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# DISEASE OF THE CERVICAL SPINE IN LARYNGOLOGICAL PRACTICE

By M. SPENCER HARRISON (London)

THE close anatomical proximity of the cervical spine to the upper respiratory tract, in particular the pharynx, exposes the vertebræ to invasion therefrom by a variety of disease processes chiefly of infective origin. This sequence of events is more commonly before the laryngologist, and is considered in Part I of this paper with a detailed description of two personal cases. Conversely, we are led to expect that primary disease of the cervical spine would manifest itself in the pharynx by the escape thereinto of inflammatory products and otherwise. This order of events is less common than the first, and is discussed in Part II of this paper with an account of one personal case.

## STRUCTURE OF THE PHARYNGEAL WALL.

The wall of the pharynx is strong and mobile; it is composed of a fibrous membrane called the pharyngeal aponeurosis, lined internally by the mucous membrane, and covered incompletely on its outer surface by a series of three overlapping muscles, the constrictors of the pharynx.

These muscles are themselves covered externally by a thin layer of fibrous tissue or fascia, which is called the buccopharyngeal fascia; this fascia is thin above and stouter below. The pharyngeal aponeurosis is thick above and blends almost into one layer in its upper part with the buccopharyngeal fascia, near the base of the skull, where the muscular coat is absent. Lower down the two fascial layers are separated by the constrictors, and become two distinct sheets. They are strengthened in the median plane posteriorly by a fibrous band descending from the pharyngeal tubercle.

External to the buccopharyngeal fascia the wall of the pharynx is in contact with loose cellular tissue by which it is connected to and separated from adjacent structures. There is an area on each side above which is not covered by the superior constrictor muscle. This area forms the sinus of Morgagni, and here the auditory tube and tensor and levator veli palatini muscles pass through the wall. The loose cellular tissue mentioned above is separated from the cervical vertebræ by the prevertebral fascia. Thus between the prevertebral and buccopharyngeal fascia lies the potential retropharyngeal space in which, up to the fifth year of life, are situated the retropharyngeal glands of Henle on each side of the midline opposite the bodies of the second and third cervical vertebræ.

## Part I.

## Disease of the Upper Respiratory Tract with Secondary Invasion of the Cervical Spine

The spine is occasionally invaded by neoplasms of the upper respiratory tract and Jones<sup>30</sup> records the case of a girl of 15 years of age with cancer of the larynx, who died of ascending myelitis due to compression or thrombosis. Such cases are, however, very rare and, in the great majority of subjects seen by the laryngologist, spinal diseases resulting from primary affections of the pharynx are inflammatory in nature.

This subject will be discussed under the following headings :

- a. Causal lesions.
- b. Mechanism of spread to the spine.
- c. Pathology.
- d. Clinical findings.

*a. Causal lesions.* The vast majority of cases of vertebral osteomyelitis occur as a sequel of a focus of infection in some other part. In some there is a septicæmia and the spinal lesion is metastatic. In others a long succession of staphylococcal lesions are observed prior to the development of the vertebral lesion. The order of frequency of occurrence of osteomyelitis in the vertebræ appears to be lumbar, dorsal, cervical.<sup>68</sup> Hahn<sup>28</sup> described 661 cases of osteomyelitis in 1895 with only one case of the vertebral type amongst them but stated that the percentage (0.15%) was probably too low owing to the failure of diagnosis of the greater number of these cases. Wilensky's<sup>68</sup> figures (578 cases) show the percentage to be no more than 1.5%. He recounts that of seventy-one published cases of vertebral osteomyelitis, twelve only occurred in the cervical spine. Turner<sup>62</sup> found two cases of osteomyelitis of the atlas amongst twelve cases of spinal osteomyelitis, and Kecht<sup>32</sup> has described two similar cases.

The upper respiratory tract is an important source of the initial focus of infection, and otitis media,<sup>10 68</sup> pharyngitis,<sup>10</sup> tonsillitis,<sup>52</sup> abscess or furuncle of nose and face,<sup>11</sup> share pride of place with lesions such as bronchitis, pneumonia, appendicitis<sup>10</sup> and typhoid fever<sup>69</sup>. Two cases of osteomyelitis of the cervical vertebræ were described recently following tonsillectomy with a normal post-operative period of several days before the onset of secondary symptoms.<sup>63</sup>

*b. Mechanism of spread.* Direct spread of the infection is less common than hæmatogenous. Kulowski<sup>34</sup> found only nine cases of direct infection in 102 cases of vertebral osteomyelitis. The infection may occur traumatically after adenoidectomy, though less commonly than might have been expected if the number of times the vertebræ are damaged at this operation is considered, after the swallowing of a sharp object (CASE II), post-operatively, or from a neighbouring suppurative

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focus such as decubitus ulcer,<sup>33</sup> carbuncle,<sup>43</sup> periesophageal abscess,<sup>34</sup> retropharyngeal abscess,<sup>44</sup> infected stab or bullet wounds,<sup>6,2</sup> and the passage of actinomycosis directly from oesophageal ulcers to the cervical vertebræ is described.<sup>5</sup>

The site of the infection in the vertebral column is usually the body in the cervical region, and the vertebral arch in the dorsal and lumbar regions.<sup>33, 68, 74</sup> Chinaglia<sup>74</sup> finds the affection often limited to one vertebra, but Kulowski<sup>33</sup> says several vertebral and intervertebral discs may be affected. This more widespread infection can only occur with infection of the vertebral bodies, with affection of the laminae and processes localization is more likely.<sup>62</sup>

With few exceptions the pyogenic organism associated with spinal epidural infection is the staphylococcus.<sup>65</sup> Several others have been mentioned in the literature such as pneumococcus,<sup>70, 47, 53</sup> streptococcus,<sup>62, 83</sup> *B. typhosus*,<sup>51, 69</sup> *pyocyaneus*,<sup>57, 54</sup> *oidium coccidioides*,<sup>18, 50</sup> and actinomycosis.<sup>37, 49, 25, 3</sup>

*c Pathology* No other location reveals so clearly as the spine that we are dealing with a septicæmia in the acute stages of pyogenic osteomyelitis. The local skeletal manifestations of the disease are of secondary importance until suppuration has occurred. The patients who die in the early acute stages do so because of intense general sepsis. The usual picture is a thrombo embolic process with its attendant suppuration and necrosis based in part upon the locally induced anæmia. The natural sluggishness of the vascular current encourages thrombosis with localization of a septic focus to a small area and in the latter stages condensation, proliferation, and bone production.<sup>64</sup> Labyerie<sup>35</sup> recognized four types of osteomyelitis of the spine, an acute true type, a subacute variety of limited extent which usually ends in an abscess, an osteoperiostitis ending in bony absorption and a chronic ankylosing osteoarthritis. The subacute type often is associated with an infectious disease such as typhoid, pneumonia, syphilis, or gonorrhœa.<sup>39</sup> The lesion is small and often superficial. Sequestration is infrequent and if it does occur is very limited. The site of the lesion in the vertebral body decides the area into which it will point.

Abscess formation is common though not invariable, but is remarkable for the extent of its migrations from the original site, due to gravitational and anatomical influences. Thus after the initial stages symptoms are usually those of the abscess rather than of the bony lesion. Abscesses follow paths of least resistance between spinal, ligamentous, and muscular attachments with their fascial sheaths and planes. The slowly forming tuberculous abscesses represent this migration classically, but the rapidly forming, large quantities of pus, that arise from insignificant initial foci, may break through barriers and wander in the most bizarre fashion, and lend further difficulties to the diagnosis, and the retracing of

the sinuses and their original sites. Any sinus in the region of the spine should call attention to these skeletal structures as possible sources of trouble. Pus of a cervical spinal epidural infection may track down intraspinally, and be evacuated by lumbar laminectomy.<sup>15</sup>

In the cervical region where the commonest location of the focus is in the bodies of the vertebræ, retropharyngeal abscess is one of the easily foreseen end-results. From this site the direction of spread of the pus is downward to the mediastinum or upward towards the base of the skull. Should the pedicles be affected, pus accumulates anteriorly and comes forwards in the cellular space in front of the anterior scalene muscles and behind the longus colli muscle, the abscess pointing in the posterior triangle of the neck, being diverted in a lateral direction by the prevertebral fascia.

A similar course may be followed by pus from a focus on the anterior aspect of the transverse process, but more frequently the abscess spreads between the anterior and middle, or middle and posterior scalenes and points in the posterior triangle between the sternomastoid and trapezius.

Abscesses from foci on the posterior aspects of the transverse processes spread backward into muscle or fascial spaces on the posterior aspect of the neck. The commonest one because of its position, develops in the thickness of the semispinalis colli. Deeply seated abscesses are the rule which develop slowly and these, when incised, are reached far down in the tissues of the neck.

Pus from the atlas and axis usually tracks to the suboccipital triangle.

Spread to the epidural space may occur and an infection supervenes limited only by the confines of the space in the acute lesions, or a small circumscribed abscess around the bony focus results, enclosing a granulomatous, irregular sclerosing tumour mass, which is likely to be diagnosed as a tuberculoma until section is performed.<sup>16 41 56</sup> There may be merely an outpouring of inflammatory exudate and a thickening of the tissues lying between the dura and bone, a pachymeningitis externa. In the severest cases there is little reaction within the space and the infection passes straight through the meninges to produce a meningitis. The latter is entirely independent of any form of meningitis which results from a hæmatogenous infection of the meninges during the course of any bacteriæmia present. Schmalz,<sup>56</sup> who does not mention direct spread in his review, evidently considers most cases to be primarily metastatic. Browder and Myers,<sup>10</sup> discovered small vertebral osteomyelitic lesions in six out of seven cases, which were so small as easily to be overlooked. This tends to confirm the view that most epidural infections of this type arise from direct spread.<sup>19 29 58</sup> Suppuration commonly occurs within the epidural space, and takes the form of an accumulation between bone and spinal dura mater. This corresponds, pathologically, with a subperiosteal abscess, and clinically, with an extradural abscess. Cases are described of rupture through one of the spinal foramina and the

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formation of simple or complex abscess on the exterior of the spine and between muscle planes and bundles <sup>68</sup>

Pressure from the acute abscess in the space is insufficient to account in many cases for the sudden and complete segmental paralysis which may occur, as the action of the abscess is seemingly over too extensive an area to produce such a localized response. Circulatory stagnation and spinal thrombosis doubtless play a part in the dramatic spinal symptomatology <sup>34</sup>. Thus it is a degeneration rather than entirely a pressure syndrome, or a stagnation oedema appears causing distension of tissue spaces and the adjacent neural fibres are affected by the compression. Removal of the cause fails to produce as rapid a relief as in tumour cases, and at necropsy pressure deformation of the cord at the level of the lesion seldom is seen <sup>12</sup>. The chronic epidural abscess on the other hand presents a similar clinical picture to fibrosarcoma of that area, as pressure is important again.

There may be (a) inflammatory exudate and oedema of the theca and surrounding connective tissue without actual pus formation, (b) extradural abscess, (c) spinal meningitis, producing from paralysis of local groups of muscles to complete paraplegia with some anaesthesia or impairment of sensation.

*d Clinical findings* In contradistinction to the slowly developing insidious symptoms of compression due to tuberculosis, pyogenic infection usually strikes with dramatic suddenness. Not uncommonly the spinal roots become involved, indirectly usually, by being surrounded by inflammatory tissue which leads to oedema and infiltration, giving rise to radiating pain. Cord symptoms are usually focal, but may not be in evidence, as sometimes extensive general involvement blots out all local and focal signs and leads to diagnostic errors. Three varieties of case may be seen, hyperacute, acute, and subacute. In the hyperacute or fulminant group, the clinical picture is that of a profound general infection the toxæmia is extreme and there is a very severe reaction <sup>68 12</sup>. Children and young adults are usually affected, high fever follows violent rigors, and the general condition quickly becomes serious, the pulse weak and febrile and the patient prostrated, blood cultures are as a rule positive, and in the most severe cases death follows in a few hours. Local signs are subordinated to the general infection and the diagnosis is obscure.

The onset is sudden also in the acute type and clinical indications of a bacteraemia are again in evidence, but local signs and symptoms are present, and in a short time those of an abscess appear <sup>60 62</sup>.

A rarer variety occurs in adults with more gradual onset and with symptoms first referred to the affected vertebræ, and unless the organism is isolated tuberculosis is likely to be diagnosed. The hyperacute type



may become slowly subacute or chronic due to the decreased virulence of the organism involved.<sup>3</sup>

A history of an original focus of infection may be ascertained, usually within two to three weeks of the onset of the acute symptoms. Boring pain in the back may be the first complaint, and there may be local tenderness over the one or two vertebræ affected. The pain is often diffuse at first, becoming localized to the area involved later. The patient assumes a tilted splinted appearance which is fairly characteristic.

With the spread of the infection into the epidural space there is a marked increase of the pain with reference along the spinal nerves.<sup>20 10</sup> This is one of the most excruciating of pains in the back, more or less constantly present, and seemingly ever increasing in severity. Paræsthesia and dyesthesia are precursors of more dramatic and later appearing signs<sup>24</sup> though with their development the pain goes or becomes less pronounced. The extremities become hyperæsthetic, and finally flaccid paralysis is evident below the upper level of the inflammation. Sphincter control is lost early, especially vesical, with first retention and often loss of desire to urinate. Deep muscle and vibratory senses persist a long time. Often an upper band of hyperæsthesia is demonstrable.<sup>4 42 60</sup> In adults and rarely in children slight dysphagia or vocal changes may be found.<sup>23</sup> Stammers<sup>160</sup> five cases of diffuse epidural suppuration all developed rigidity of the spine which upon analysis proved to be absolute limitation of flexion with free hyperextension, this spread to involve more and more of the spine.

The lumbar puncture demonstration of a partial or complete spinal subarachnoid fluid block often provides final conclusive evidence that a space occupying lesion is present. In performing the test jugular compression should be applied on both sides at once. Unilateral compression is necessary only when patency of one lateral sinus is in doubt. Promptness and rapidity of fall of fluid on release of the jugular veins is of more positive value than the rate and extent of the preceding rise of fluid level. Incomplete compression might cause a slow rise, but there is no dubiety about a sudden fall. The patient must be very relaxed and breathing quietly.<sup>4</sup>

If an epidural spinal infection is suspected lumbar puncture gives extremely valuable information but should be done with caution if over the suspected level of the lesion. The aim should then first be to try to hit the lamina of the adjacent vertebra and thereafter the needle should be advanced slowly and the stylet withdrawn at each 2-3 mm. to test by aspiration for pus. After pus is found the needle should be removed as penetration of the subarachnoid space may produce meningitis.<sup>43</sup> Simultaneous cisternal and lumbar puncture are helpful in a number of cases giving a valuable check if doubtful results are obtained by the latter.

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Fluid above and below the block can then be compared. The cerebrospinal fluid is usually clear and may show xanthochromia. 50-1,000 cells per c.mm. may be present, chiefly polymorphs and lymphocytes. Protein often is raised to over 100 mgms.%, sugar is normal and a meningitic gold colloidal reaction may be seen at times. Culture and smears will be negative in the absence of meningitis.

*Radiology.* There is a tendency to place too great reliance on X-ray examination of the spine in these areas which are even more unsuited to satisfactory investigation by X-rays, more particularly in the early stages,<sup>11 62 66</sup> than are cases of osteomyelitis of the long bones. The focus is usually small, deeply placed beneath large muscles, and may be viewed through a thick layer of vertebra with processes of varying density. In the absence of destruction and collapse new bone may be absent. Soft tissue paravertebral shadows incident to attendant oedema or abscess formation may be an early sign. Smith<sup>59</sup> states that in tuberculosis one of the earliest evidences of osteomyelitis is X-ray thinning of the intervertebral disc. A slight haziness and indistinctness of the trabecular architecture may be seen in the early stages. Antero-posterior and oblique views are useful. Many of the most important early signs are seen in antero-posterior view, such as static deviations, para-osteal calcifications, localized vertebral destruction, and intervertebral space changes. Sequestration, mottling of the vertebræ, and varying degrees of erosion, and destructive phenomena are less common. Later, wedging of the disc may be seen, and the presence of reactive bone formation about the periphery of the vertebræ with resultant bony bridging always is present sooner or later in the disease.<sup>34 62</sup> New bone formation is often very extensive and even fusion may be relatively early.

*Diagnosis.* The most frequent error underlying the failure to diagnose vertebral osteomyelitis or spinal epidural infection is that it is not entertained as a possibility. There is lack of emphasis in textbooks, and little mention of it clinically.

A history of prior infection followed by severe boring pain in the back, toxic symptoms, paresis, and meningitic signs is suggestive. An absolute diagnosis is only made on bacteriological and histological grounds. Injection of sinuses and X-ray examination may lend a clue as to the origin of the infection. Bacteriological and microscopic examination and guinea-pig inoculation of scrapings from sinuses are useful, as tuberculosis is the most difficult disease to differentiate from the subacute pyogenic infection. Blood culture and white counts may be of great use, sedimentation is useful as an indication of the general trend of the disease and the degree of operative risk:

Tuberculosis is not usually cervical and deformity is uncommon. The pyogenic type as buttressing of weak spots by new bone te

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occur. Pain in Pott's disease is relieved by rest. On X-ray, tuberculosis shows rarefaction, lack of new bone formation, and no exostosis, at the stage when diagnosis is important.

A chronic epidural abscess is often indistinguishable from an extradural tumour, and in many cases reported in literature the diagnosis was fibrosarcoma.<sup>15</sup> Amongst other conditions causing difficulty have been staphylococcal septicaemia, Scheuerman's disease<sup>46</sup>, arthritis of the spine, encephalitis, meningitis, soft tissue abscess, mycotic lesions, poliomyelitis, undulant fever, typhoid fever, subacute bacterial endocarditis, trauma, metabolic bone disease, and even senile kyphosis.<sup>68</sup>

*Prognosis.* Excluding the hyperacute variety, the prognosis is better than is generally appreciated if early diagnosis and treatment are possible. Kulowski<sup>34</sup> described a 25% mortality in 92 cases with no cord involvement, but 50% with such involvement in ten cases (1 infarct of cord, 4 meningitis, 4 cord compression by inflammatory exudate, and 1 extradural abscess). Even this is a considerable improvement upon the 76% total mortality of less than half a century ago.<sup>36</sup>

There are divided opinions as to the advisability of operation; in Boyce's<sup>9</sup> series 25 cases (100%) died without surgery, and of 16 cases drained only 4 died, 8 recovering completely; but modern chemotherapy may be changing the indications for delay, as the excellent blood supply, and the usual absence of gross pus and sequestration, may combine to make traction and chemotherapy satisfactory without other treatment, especially is this so before the infection has spread to the epidural space. Sulphonamide alone may fail to arrest progress completely, and yet mask precise localization, necessary before surgical intervention by preventing gross pus formation. The addition of penicillin, or this latter drug alone may produce good results without surgery, as in a case described by Scoville<sup>55</sup> and in case II. Recovery may occur after the condition has progressed to meningitis.<sup>43</sup>

*Treatment.* The treatment of acute pyogenic osteomyelitis of a cervical vertebra is a difficult technical and mechanical procedure if adequate drainage, should this be undertaken, and proper support are to be achieved. Collapse and compression may need to be overcome. Drainage is made more difficult as the lesion is usually anterior to the cord. If no surgery is considered and no deformity is obvious on X-ray, a plaster of Paris cast to the neck may produce enough fixation. Should surgery be undertaken a preliminary skull traction by tongs, or a piano wire through bilateral parasagittal burr holes will be useful.<sup>46a</sup> White<sup>67</sup> states that there are not many diseases in which a few hours' delay may lead to such dire results. This is true only in certain cases as has been shown. Several successful reports in literature are ascribed to conservative treatment.<sup>59</sup> In the hyperacute cases the patient rarely lives long



FIG 1

Showing marked lipping of cervical vertebrae with soft tissue projection into pharynx, visible on inspection just below level of soft palate

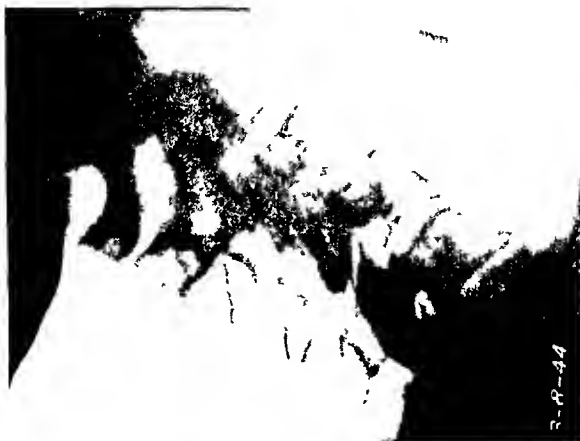


FIG 2

Early loss of density of anterior tips of 4th and 5th cervical vertebrae

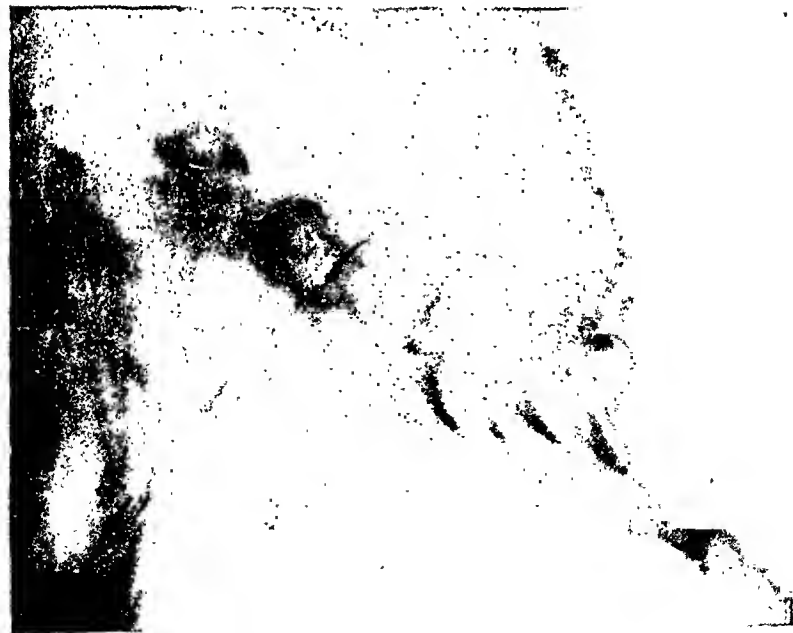
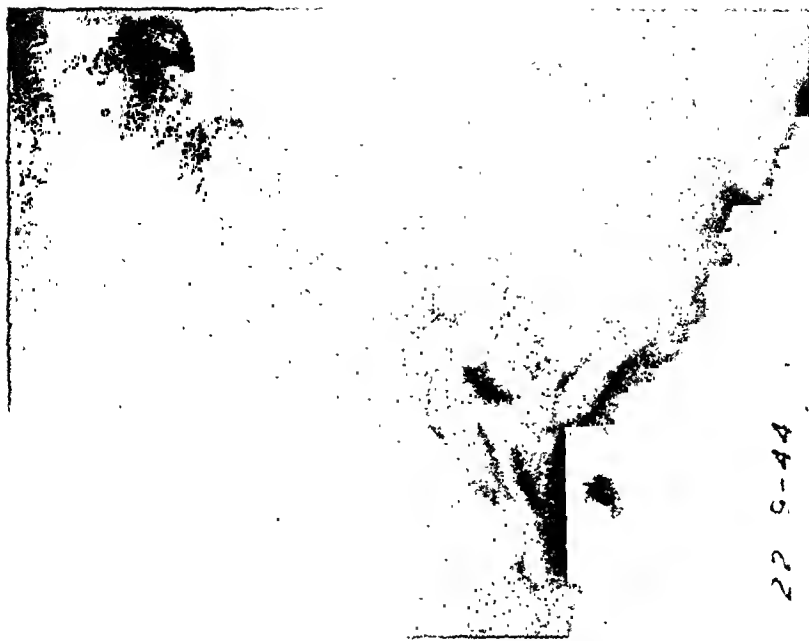


FIG. 3.  
Showing increased bony destruction. Compare Fig. 2.



22 5-44  
FIG. 4.  
Showing commencing bony bridging. Compare Fig. 3.



FIG 5  
Showing advanced bony bridging

enough  
after  
S  
abs  
ma  
an  
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rh

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enough for local treatment. Turner<sup>62</sup> considers that recovery of paresis after decompression is unusual.

Simple adequate incision will suffice for most localizations when an abscess is present. If infected bone exists in the posterior processes it may be identified in the floor of the sinus by the characteristic roughening and should be removed. The vertebral bodies should not be attacked except for biopsy, for anatomical reasons, and as the danger of hæmorrhage is great.

### SPONTANEOUS HYPERÆMIC DISLOCATION OF THE ATLAS.

*Causal lesions.* The first case of this condition was described by Sir Charles Bell<sup>7</sup> and was caused by an ulcer of the back of the throat. Any infection with resulting hyperæmia in the region below the base of the skull is a predisposing factor. Thus it may be associated with tonsillitis,<sup>23 61 22 27</sup> pharyngitis,<sup>8 17 30</sup> otitis media, mastoiditis,<sup>30</sup> cervical adenitis,<sup>30</sup> retropharyngeal abscess,<sup>28</sup> scarlet fever,<sup>8</sup> coryza,<sup>8</sup> acute influenza<sup>30</sup> and acute rheumatism.<sup>22</sup> A direct connection between the focus and the atlas is unnecessary.

*Pathology.* A variety of organisms may be isolated, most often the pyogens and tubercle. Bell's case was syphilitic.

There is a hyperæmia, but not necessarily infection of the bone, the attachments of the transverse ligaments are loosened, and the anchorage of the odontoid to the atlas is thus unstable, forward subluxation of the atlas therefore may develop spontaneously.

*Clinical findings.* Four clinical stages have been described<sup>32</sup> which pathologically are similar and the differentiation dependent on the degree of displacement.

Slight torticollis, painful neck movements, and muscular spasm indicate movement of the atlas forward with slight rotation (Stage I.).

(Stage II.) With increased displacement compression of the cord commences, but the dislocation is reducible, and the paresis recoverable. Only one case has been described<sup>32</sup> of recovery from the quadriplegia in Stage III. Sudden death due to paralysis below the level results from complete dislocation (Stage IV.).

*Radiology* is made difficult by the torticollis, the dislocation is a rotatory one and hard to demonstrate by the open-mouth position for this region. Laminographs often are of considerable help,<sup>45</sup> or a basal view of the skull to show the relation between atlas and axis.<sup>21</sup> Normally the posterior surface of the anterior arch of the atlas and the anterior surface of the odontoid process are in contact radiologically.

*Treatment* is conservative and along the same lines as described for osteomyelitis of the cervical spine, though short immobilization is all that is necessary. Traction helps to lessen pain and discomfort (Case III.).

Actual osteomyelitis may occur in the atlas as noted previously.



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## Part II.

### Lesions of the Cervical Spine presenting in the Pharynx

The most frequent sign in the pharynx of vertebral inflammation is retropharyngeal abscess,<sup>33</sup> which may be acute or chronic. The acute type is almost invariably the result of infection of the pharyngeal wall with secondary spread into the retropharyngeal lymph nodes, but it may be a manifestation of pyogenic osteomyelitis of the cervical spine, if this latter lesion is located chiefly in the anterior part of the body of a vertebra. In the cervical spine the most common site for the focus of infection is in the vertebral body. Suppuration forming on the anterior surface of the bodies accumulates first between the bone and the prevertebral fascia. This is one of the rarer causes of retropharyngeal infection so frequent in children;<sup>67</sup> Carson<sup>13</sup> has described a case of this type in an adult.

The chronic abscess is most frequently associated with tuberculosis of the bodies of the cervical vertebræ, but almost as often it arises in connection with the prevertebral glands apart from infection of the vertebræ.

Severe lipping of the anterior parts of the vertebral bodies produces symptoms and signs in the pharynx. Sensations of prickling and a feeling of fullness, or of a foreign body in the posterior wall of the pharynx may prove to be associated with evidence of arthritis of the spine demonstrable in lateral X-ray films. CASE I illustrates this.

CASE I. Mr. A.—The patient was seen in the Out-Patient Department complaining of a "prickly feeling in the throat" and of stiffness of the neck of five to six years' duration. Onset had been coincident he thought with the swallowing of a bone.

Examination showed a hard lump on the posterior wall of the oropharynx. X-ray shows the condition to be one of marked osteoarthritis of the cervical spine, and a soft tissue shadow can be seen protruding into the pharynx (Fig. 1).

CASE II. Mrs. McA.—Three weeks before admission, the patient, a female of 50 years, was eating a sausage and felt something stick in her throat on the right side. She was unable to eat more of the meal and had considerable pain in the throat. Dysphagia continued and she lost her voice 4-5 days later.

On admission her temperature was 100°F., and she was obviously in pain when asked to swallow. The right upper anterior cervical glands were tender and slightly enlarged.

Indirect laryngoscopy showed the right cord red and swollen and all the soft intrinsic laryngeal tissues on that side infiltrated with inflammatory exudate. This included the right ary-epiglottic fold. Direct laryngoscopy showed an ulcerated abrasion size of 6d. in right pyriform fossa with some obvious sloughing.

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A course of sulphathiazole (25 grams over 4 days) was commenced after the operation and the patient improved for one week, though she complained of tenderness in right side of neck posteriorly, dysphagia, and rigidity of neck, and was given short wave treatment. At this time the diagnosis was inflammation of the extrapharyngeal soft tissues, very localized and without pus formation, and secondary to a puncture wound of the pharyngeal wall. But the improvement was short-lived and the temperature rose once more and became spiky and septic type. The pain in the neck also increased. A second laryngoscopy showed "granulation tissue in the right pyriform fossa, no pus, and no foreign body." Sulphathiazole (28 grams over 5 days) was given again three weeks after admission, and a third laryngoscopy one week after the second revealed "granulations round a punched out hole in the right lateral part of the posterior wall of the laryngo-pharynx, just below the arytenoid. A probe was inserted easily, and bare bone contacted, no pus discovered in quite a large excavated area beneath mucosa of posterior wall of oesophagus. Biopsy of Granulations." Report of biopsy "Acute and chronic granulation tissue—no evidence of neoplasm." White blood cells were now 11,450 with 22% neutrophils. Pain in neck had increased, and a marked cervical adenitis had been present, but after the final laryngoscopy pain and adenitis lessened in intensity and though temperature continued spiky with rises up to 102, patient felt better.

Chest X-ray revealed a small right pleural effusion with left interlobar effusion. (This lesion added a serious difficulty to diagnosis, but had returned to normal ten days later.) A rigor occurred five weeks after admission, condition again regressed, and the temperature became more septic in nature. Blood culture was sterile. Further chemotherapy was tried (Sulphadiazine 29 grams over six days). Lumbar puncture at this time showed cerebrospinal fluid pressure 230 mm. Queckenstedt negative, 78 cells per c mm (polymorphs 40%, lymphocytes 40%, degenerated cells, probably endothelial, 20%). Total Protein 36 mgm %. Culture sterile. About this time patient began to have difficulty in feeding herself, and the power in her arms was lost with anæsthesia affecting the distribution of C<sub>5</sub> to C<sub>8</sub>. The lower limbs showed decreased jerks, but anæsthesia was only partial. White blood cells 14,100 (86% neutrophil). Two days later retention of urine developed and tidal drainage of the bladder was commenced. Constipation was increasing. The neurologist, who kindly examined the patient reported "Head held in flexion, marked discomfort on any attempt to move it. No power in right shoulder. Weak adduction of left shoulder possible. No power of flexion of either elbow. Muscles flaccid.

Reflexes. Reversal of supinator and biceps jerks. No abdominal reflexes. Extensor response of toes.

Weakness of all muscle groups of legs with exaggerated reflex responses

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Sensory responses of legs normal, but of arms poor. Position sense absent, astereognosis right and left hands.

Distribution of defects corresponds to C<sub>5</sub> and C<sub>6</sub> chiefly. Probably cervical inflammatory mass."

The Neuro-Surgical Department recommended neck fixation to relieve pain of muscle spasm, and to guard against spontaneous dislocations, and heparin to lessen tendency to thrombosis. Plaster of Paris was easier to use for fixation than calliper forceps, and a P.O.P collar was applied.

Four hourly intramuscular injections of 20,000 Oxford Units of Penicillin were given for six days, and patient showed considerable improvement during this time. Retention of urine ceased and temperature fell. But a fortnight later the temperature rose to 100°F. for two days, and a further four days course of penicillin was administered.

White blood cells were now 5,700 (polymorphs 59%) Lumbar puncture showed a cerebrospinal fluid pressure of 320 mgms. with a respiratory recursion of 10 mm. Queckenstedt still negative, two cells per c. mm. total protein 50 mgms.% a trace of Globulin, and Wasserman negative.

The power and movements of the upper limbs slowly returned to normal and six months after the initial lesion the patient was walking spastically but well and had full use of her arms other than for such restriction as was imposed by the plaster collar and shoulder pieces. The collar was worn for 3½ months.

Serial X-rays show bony changes, these were taken before plastic collar was applied, and when it was removed for changing (Figs. 2, 3, 4, 5).

CASE III. B.J.—A female child aged 9 years was seen in a Native Hospital in Nigeria. She had been admitted with marked torticollis, scoliosis of the lower cervical region, and head fixation. She would allow no movement of the head, and objected to recumbency. Her left shoulder was higher than the right.

Patient had had a severe sore throat a few days prior to the onset of the present symptoms and had shown evidence of a febrile reaction.

Temperature on admission was 102°F. and there was tenderness of the neck below the occiput. The tendon reflexes showed hyperactivity and the Babinski tests were indefinite. Some weakness of the upper extremities was shown to be present, but no sensory and no sphincter changes. X-ray facilities were inadequate and a very unsatisfactory picture of the cervical spine was obtained.

The patient was placed with her head between sandbags after lumbar puncture had been performed (pressure slightly increased, cells 5-6 per c.mm.) and sulphanilamide was given orally. This method of fixation was inadequate and as her condition did not improve over four days a plaster of Paris helmet was applied under an anæsthetic and

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traction therefrom used for twelve weeks. Afterwards the patient's condition appeared satisfactory and no return of cervical condition was noted over a further three months.

## Summary

The pathology of the cervical spine in relation to that of the ear, nose, and throat is discussed and illustrated by case histories.

Lesions of the spine may present in the pharynx as retropharyngeal abscesses, or arthritic lipping may push forward the mucosa in front of them.

Infection may be conveyed to the vertebrae or to the epidural space by the blood stream or *viâ* the lymph channels, directly as a result of injury, or by direct spread.

Hyperæmic dislocation of the atlas vertebra, osteomyelitis of the cervical spine, and epidural infection are related frequently to disease of the ear, nose, and throat.

The writer is indebted to Mr D F A Neilson for valuable suggestions and for permission to publish CASES I and II, and to Mr C S Hallpike for a great deal of helpful criticism.

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## NASAL SINUS PAIN CAUSED BY FLYING (THE SYNDROME OF SINUS BAROTRAUMA)

### AN ANALYSIS OF 145 CASES

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#### Definition

SINUS barotrauma is a condition in which pain, occasionally accompanied by other symptoms and clinical signs develops in the frontal region or over the cheek during or shortly after a flight in aircraft. It is caused by a difference between the pressure of the air contained within one or more of the nasal sinuses and that of the atmosphere. The inequality of the pressures is brought about by change of altitude in the presence of some temporary or persistent contributory factor which causes occlusion of the sinus ostium. As explained later the contributory factors, many of which would ultimately require treatment irrespective of barotrauma, vary from some developmental abnormality to gross sinus disease.

One hundred and forty five carefully selected cases are analysed in these notes and only patients who complained of pain which first developed during—in one case shortly after—a particular flight have been included. In many the pain recurred during subsequent flights and in some it persisted for variable periods after landing. Anyone who gave a history of pain and other symptoms the onset of which was not considered to be the direct result of flying has been excluded, and those who complained of headache, as distinct from pain, have not been included for although the differentiation is somewhat loose, an hysterical origin of symptoms was suspected in most of the former cases.

## Incidence

The incidence is difficult to assess. Official figures regarding the incidence of sinus barotrauma are unreliable as in many patients the contributory factor clinically has overshadowed the effects of the barotrauma so that for statistical purposes these cases have been classified under the heading of the contributory factor—e.g. sinus barotrauma arising in an infected antrum has been classified as "sinusitis".

One hundred and forty-five patients who complained of sinus pain which appeared to be attributable to flying have been examined in this Hospital during three and a half years. The incidence, however, is undoubtedly higher in this area than these figures suggest because many patients do not report their symptoms, whilst others suffering from less severe and non-recurrent attacks are not referred to Hospital. Of a recent series of one thousand air-crew cadets who were subjected to a standard low pressure test simulating an altitude climb to 10,000 feet, eighteen (six of whom were suffering from coryza) complained of symptoms of sinus barotrauma during recompression (Dickson, McGibbon, Harvey and Turner, 1943).

Campbell (1944) has stated in an article published since these notes were originally compiled, that "aero-sinusitis presents an incidence of about one-twentieth that of aero-otitis media". In this Hospital the relationship has been approximately one case of sinus barotrauma to four of acute otitic barotrauma, and the ratio was one to five in the experimental series mentioned above.

## Aetiology

A difference of pressure of the air contained within a sinus and that of the atmosphere will result if the sinus ostium is occluded by any developmental or acquired formation which acts as a valve and so permits of air flow through the ostium in one direction only during changes of altitude.

The valve-like formations which may be either fluid or tissue are regarded as the "contributory factors" in the production of sinus barotrauma. Voluntary efforts to ventilate the sinuses do not appear to relieve or arrest the symptoms once they are initiated and the syndrome in this respect differs from acute otitic barotrauma in which auto-inflation is so frequently effective. Age, amount of flying experience, nature of air-crew duties, and type of aircraft flown, are not predisposing factors and the aetiology of the syndrome therefore is that of the many contributory factors classified in Table I. The mechanisms by which some of these contributory factors may produce occlusion of the ostium of a sinus are illustrated diagrammatically in Fig. 1.

# Nasal Sinus Pain caused by Flying

It must be emphasized that in a large number of patients, particularly those in whom the only abnormal signs were radiological, it has been impossible to differentiate cause from effect of the barotraumatic change and doubtless in many the clinical and/or radiological findings were the result of a combination of both, or they may have been merely coincidental and unassociated with the barotrauma.

In thirteen (8.9 per cent.) patients there was neither clinical nor radiological evidence of a contributory factor or of barotraumatic change

TABLE I

## POSSIBLE CONTRIBUTORY FACTORS OF SINUS BAROTRAUMA

- A *Developmental*
  - (1) Developmental valvular folds of mucous membrane (A 1 and D 1, V, Fig 1)
  - (2) Pressure by a deviated nasal septum, middle turbinate or ethmoidal cells
- B *Traumatic*
  - Obstruction due to traumatic intranasal deformities
- C *Allergic*
  - (1) Swelling of the mucosa (A 2 and D 2, M, Fig 1)
  - (2) Polypoid (A 3 and D 3, P, Fig 1)
  - (3) Mixed (1) and (2)
- D *Infective*
  - (1) Acute and chronic uncomplicated rhinitis (D 2, M, Fig 1)
  - (2) Sinusitis
    - (a) Hyperplastic (A 2 and 3, M and P, Fig 1)
    - (b) Effusive-serous, sanious or purulent (A 4 and D 4 S, Fig 1)
    - (c) Mixed (a) and (b).
- E *Neoplastic*
  - Obstruction by a simple or malignant new growth
- F *Mixed*
  - Any combination of A, B, C, D and E

and of these one refused treatment, one was placed on limited flying duties, two were referred to higher authorities for disposal and in nine the symptoms were considered to be hysterical

## A, AND B. DEVELOPMENTAL AND TRAUMATIC

Although they vary in size and shape, the ostia of the sinuses as a rule are ovoid; sometimes they are slit-like and occasionally they are surrounded by valvular folds of mucous membrane. A 1, V and D 1, V (Fig. 1) represent developmental soft-tissue flap-valves and their mode of action is obvious. In a few individuals the ostia are actual tunnels and it may be assumed that in some cases the fronto-nasal canal is a compressible tube which is subjected to a pressure occlusion owing to a time-lag factor, in a manner similar to that of the eustachian tube in the production of acute otitic barotrauma (McGibbon, 1942). That



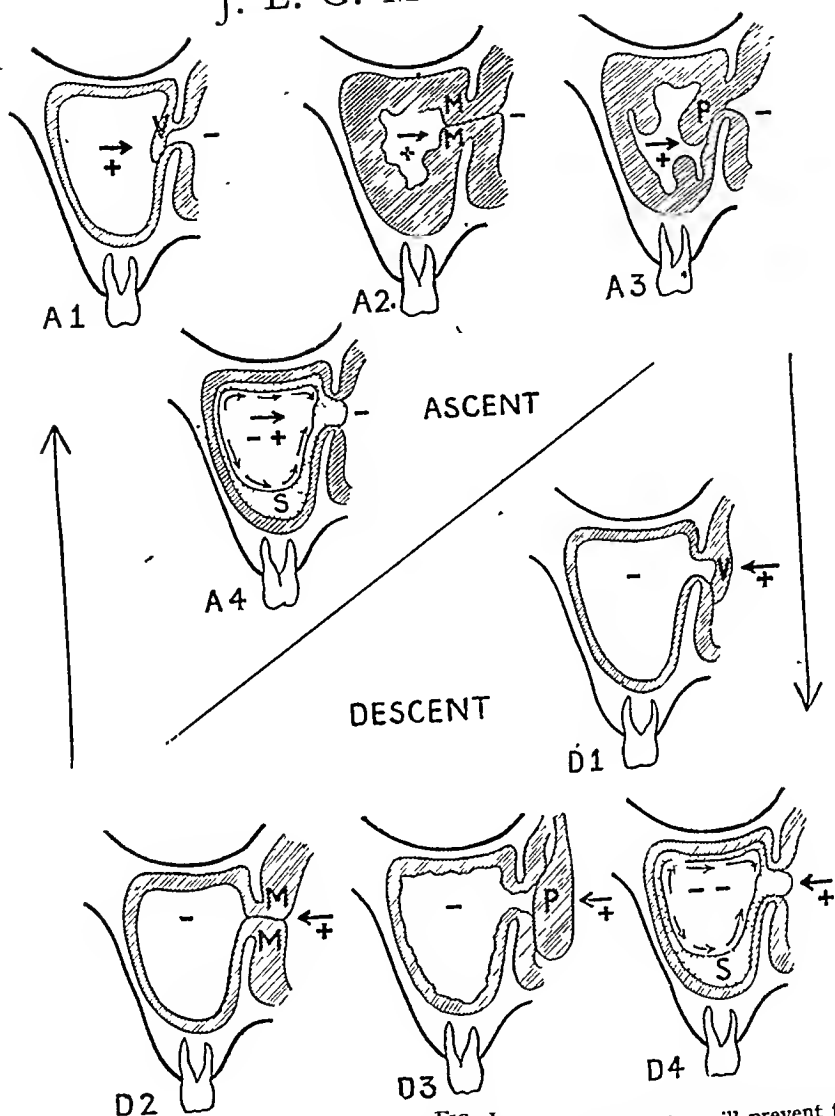


FIG. 1

A. During ascent any valvular formation within the sinus cavity will prevent the exit of air from the sinus as the atmospheric pressure decreases. D. During descent and increase of atmospheric pressure similar formations on the nasal side of the ostium will prevent the entrance of air into the sinus.

A. Ascent

A 1. V—Developmental flap-valve formation of sinus mucous membrane.

A 2. M—Swelling of the mucosa of sinus with flutter-valve effect.

A 3. P—Mucosal polypus in sinus constituting a ball-valve.

A 4. S—Effusion in sinus cavity acting as an exhaust-piston.

} Allergy or Infection.

D. Descent.

D 1. V—Developmental flap-valve formation of nasal mucosa.

D 2. M—Swelling of nasal mucous membrane with flutter-valve effect.

D 3. P—Polypus presenting in nasal fossa and acting as a ball-valve.

D 4. S—Effusion in sinus cavity with exhaust-piston effect.

} Allergy or Infection.

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pressure by a deviated nasal septum, by a middle turbinate and/or ethmoidal cells is a possible contributory factor is supported by the finding that nineteen (13.1 per cent. of the total series) of twenty-three patients who were operated on for these conditions (eight by submucous resection, thirteen by partial middle turbinectomy and two by a combined operation) returned to full operational flying duties without recurrence of symptoms. It is possible that in some of these nineteen apparently successful cases, improvement of the nasal airways caused resolution of a mild secondary chronic rhinitis which had been the actual contributory factor.

### C. ALLERGY

An allergic reaction may manifest itself by swelling of the mucosa of the nasal fossae and sinuses and/or by the formation of polypi.

A 2, M and D 2, M (Fig. 1) show diagrammatically the manner in which swollen mucosa may act as a flutter-valve—during ascent if the swelling is situated on the sinus side of the ostium (A 2, M) and during descent if the swelling is on its nasal aspect (D 2, M).

It has been pointed out by Proetz (1939) that the relative patency of the ostium is determined by the condition of the mucous membrane; that whereas the sinus mucosa is thin and contains few glands, the nasal mucous membrane is several times thicker and contains many glands; and that as the change in character of the mucosa occurs abruptly somewhat short of the ostial margin, the lining of the ostium is in fact a part of the nasal mucosa. It can be appreciated therefore that swelling of the mucous membrane of the nasal fossae caused by allergic and infective agents will tend to be of greater extent and in closer proximity to the margin of the ostium than will be that of the mucosal lining of the sinuses. This may partly explain the more frequent development of the syndrome during descent than during ascent.

A 3, P and D 3, P (Fig. 1) demonstrate the manner in which a polypus may act as a ball-valve—within the cavity during ascent and in the nasal fossa during descent.

In three patients (2.0 per cent.) an allergic reaction was considered to be the contributory factor. Two were relieved by the use of ephedrine locally and by mouth, and one who had polypi in both antra and in his nasal fossae was treated surgically. All returned to full operational flying duties without further complaint.

### D. INFECTION

(1) *Acute and chronic uncomplicated rhinitis* give rise to swelling and congestion of the mucosa of the nasal fossae with a variable amount of mucoid or muco-purulent secretion.

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The manner in which swollen nasal mucosa may act as a flutter-valve has been described above and is illustrated in D 2, M (Fig. 1).

Forty-three patients attributed their symptoms to flying whilst suffering from a "cold" or "catarrh". The clinical and/or radiological findings in these patients are shown in Table II.

TABLE II

RHINOLOGICAL AND/OR RADIOLOGICAL FINDINGS IN 43 PATIENTS WHO ATTRIBUTED THEIR SYMPTOMS TO FLYING WHILST SUFFERING FROM A "COLD" OR "CATARRH"

Acute or chronic uncomplicated rhinitis ..	13
Acute rhinitis with swelling of mucosa of sinuses	11
Deviated nasal septum .. .. .	2
Polypi in sinuses .. .. .	4
Serous effusion in antra .. .. .	2
Pus in one or more sinuses .. .. .	10
Pus and polypi in antra .. .. .	1
Total .. .. .	43

In all forty-three patients the changes observed *might* have been the contributory factor, whilst in twenty-eight the findings *could* have been partially or wholly the result of barotrauma—i.e. mucosal thickening, polypi, effusion and pus in the sinuses. Campbell (1941) has drawn attention to the possibility of aspiration of infective material into the sinuses as a result of changes of pressure, and of a consequent suppurative sinusitis; and he has since referred to this as "non-obstructive aerosinusitis" (1944).

(2) *Sinusitis*. Under this heading, except in cases of chronic sup-puration or gross hæmorrhage, it is frequently impossible to distinguish the contributory factor from the effects of barotrauma.

(a) *Hyperplastic sinusitis* is diagnosed by X-ray and it includes mucosal thickening and polyposis of the lining of one or more sinuses. The mucosal thickening may be localized or general throughout the sinus; in a few patients who were operated on these localized thickenings proved to be exceedingly thin-walled collections of fluid in the mucosa. The manner in which these abnormalities may act as flutter-valves (A 2, M, Fig. 1) or ball-valves (A 3, P, Fig. 1) has already been described. Hyper-plastic sinusitis is a frequent finding in allergic states and infections of the upper respiratory tract.

In fifty-six patients X-ray of the sinuses demonstrated thickened mucosa with or without polypus formation and/or effusion, "hazy appearance" or "hazy outline" (Table VII). In three of these pus was found by lavage of the antrum and in one case at operation a "polyp" of the frontal sinus proved to be an organizing submucosal hæmorrhage (Fig. 2):

Pilot Officer Sm., Pilot, æt. 29 years. Total flying hours 550.

24.10.43. Whilst losing height from 10,000 feet to 2,000 feet experienced very severe pain above and behind his left eye which caused lachrymation.

## Nasal Sinus Pain caused by Flying

He had no cold at the time. When he landed the pain went off but it left a headache which lasted for 2-3 hours.

1.11.43. During a night-flying test he experienced no discomfort although he dived from 10,000 feet.

3.11.43. Whilst on an operational sortie the pain recurred when the aircraft reached 11,000 feet, and it became so severe that the trip had to be abandoned.

He then had persistent left frontal headache until he was examined on 5.11.43. Clinically there was no manifest lesion but X-ray showed a "polyp" of the anterior wall of the lateral third of left frontal sinus (Fig. 2). This failed to resolve in spite of conservative treatment, and he had recurrences of severe pain during tests in aircraft and in the decompression chamber.

31.3.44. Left frontal sinus explored by the external route and an organizing submucous hæmorrhage found and removed.

Patient subsequently returned to full flying duties without recurrence of symptoms.

It is probable that other radiological "polypi" were in fact unrecognized submucosal hæmorrhages. Herrmann (1940) has reported four cases of submucosal hæmatoma of the frontal or maxillary sinuses, and Campbell (1944) two cases of submucous hæmorrhage in the frontal sinuses of aviators. The diagnosis in their cases was made apparently on radiological evidence alone.

In addition to the allergic case already mentioned, multiple polypi in one patient and a solitary polypus in two patients were visible by rhinoscopy. These were all treated surgically, and two returned to full and one to limited operational flying duties without recurrence of symptoms.

(b) *Effusive sinusitis*. Fifty-seven patients are included under this heading in whom fluid—serous, sanious or purulent—was diagnosed clinically and/or radiologically in one or both maxillary antra and/or frontal sinuses.

A 4, S and D 4, S (Fig. 1) illustrate blockage of the sinus ostium by fluid and the consequent reduction of pressure in the sinus cavity is explained by the recent work of Hilding (1943). He showed that in a dog's frontal sinus which contained mucus, ciliary action alone caused a reduction in pressure of 66 mm. water, as the cilia continually swept the mucus towards the sinus ostium where it formed an occlusive mass and acted as an exhaust-piston. This exhaust-piston effect depends upon the relationship between the size of the ostium and the viscosity of the effusion and as ciliary action is not abolished by the presence of pus (Proetz, 1933), the phenomenon could occur with purulent or non-purulent effusions.

It will be seen from A 4, S (Fig. 1) that during ascent ciliary action will tend to reduce the air pressure in the involved sinus and thereby militate against the development of sinus barotrauma, although it is

possible that a very viscid secretion might block the ostium in spite of the two forces (relatively increased sinus pressure and ciliary action) and so give rise to sinus barotrauma. During descent (D 4, S, Fig. 1) ciliary action will lower the pressure inside the affected sinus and thereby bring about or contribute to barotrauma. This may be an additional reason that sinus barotrauma occurs more frequently during descent than during ascent.

Hilding's (1943) work also helps to explain the mechanism of the production of some cases of "delayed" otitic barotrauma and possibly that of "delayed" sinus barotrauma mentioned in these notes.

Non-purulent antral effusion was diagnosed by proof-puncture in four patients, in one associated with thickened mucosa and in another with an effusion in a frontal sinus.

A bloody antral effusion was found in one patient by proof puncture and a similar effusion was assumed to be present in two others who blew "congealed" and "stale" blood from their nasal fossae. A fourth patient with a solitary polypus which apparently caused occlusion of the ostium of the antrum during loss of height (as illustrated in D 3, Fig. 1) was considered to have an antral hæmorrhage :

Flying Officer S., rear-gunner, æt. 37 years. Total hours flown 200.

1940. Had polypi removed from both nasal fossae.

22.12.42. Lost height rapidly from 18,000 feet to 7,000 feet to avoid searchlights. Ten minutes after the dive he experienced very severe pain over his left eye, which subsided in a few days.

29.12.42. X-ray showed left antrum opaque.

6.1.43. Examination revealed a small polypus under the left middle turbinate, and his left antrum was dark on transillumination.

22.1.43. During a decompression test whilst being recompressed from a pressure corresponding to 18,000 feet to that of 10,000 feet, severe pain developed behind his left eye and over the left frontal region, and subsequently he blew blood and mucus from his nose.

10.2.43. The polypus was removed and three weeks later he returned to full operational flying duties without recurrence of symptoms.

Purulent effusion was present in one or both antra of thirty-one (21.3 per cent.) patients. In two others in whom an antrum was reported as opaque, lavage gave a clear return fluid.

Effusion was shown radiologically in the frontal sinus of four patients and in two this was associated with thickened mucosa. In fourteen (9.6 per cent.) patients the frontal sinus was reported as opaque, and the cause of opacity was assumed to be an effusion although this could not be proved.

The clinical and/or radiological findings described above are shown in Table II and an attempt has been made to separate them into cause and effect of barotrauma :—



FIG 2

Print from radiograph of Pilot Officer Sm showing submucous hæmorrhage of lateral third of the left frontal sinus



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TABLE III

CLINICAL AND/OR RADIOLOGICAL ABNORMALITIES FOUND IN 132 PATIENTS

Clinical and/or radiological abnormality	Probably contributory factor alone	Probably contributory factor Possibly barotraumatic change	Probably combined contributory factor and barotraumatic change	Probably barotraumatic change alone	Totals
(1) Deviated nasal septum and/or enlarged middle turbinate	10	—	—	—	10
(2) Uncomplicated rhinitis	13	—	—	—	13
(3) Thickened sinus mucosa and/or polypi and/or effusion	—	—	54	—	54
(4) Submucous hæmorrhage in frontal sinus	—	—	—	1	1
(5) Hæmorrhagic effusion in antrum	—	—	—	4	4
(6) Non-purulent effusion in antrum	—	—	—	3	3
(7) Pus in antrum	—	31	—	—	31
(8) Effusion (? nature) in frontal sinus	—	—	2	—	2
(9) Opaque (? cause) frontal sinus	—	14	—	—	14
Totals	23	45	56	8	132

## E NEOPLASTIC

No cases of innocent or malignant neoplasm have been seen in the present series but it is possible that a new growth could behave in a valve-like manner at a sinus ostium

## F. MIXED

Probably in many cases the contributory factors were some combinations of A, B, C and D.

## Association with other Flying Disabilities

### ACUTE OTITIC BAROTRAUMA

Fifteen (10.3 per cent.) of the patients developed acute otitic barotrauma simultaneously with the sinus lesion. This percentage corresponds closely to that observed in the experimental series already



mentioned—acute otitic barotrauma occurred in two (11.1 per cent.) of the eighteen cadets who developed sinus barotrauma.

#### NEUROPSYCHIATRIC SYMPTOMS

As the diagnosis of sinus barotrauma is founded very largely on the patient's complaint of pain, the syndrome lends itself to hysterical mimicry and perpetuation as a means of escape from operational flying duties. Eighteen (12.4 per cent.) patients were considered to be psychiatric cases and in nine of these there was no clinical or radiological evidence of barotraumatic change or of a contributory factor.

Seven (4.8 per cent.) patients had been involved in an aircraft crash without injury to their nasal sinuses at periods ranging from ten days to three years before the onset of sinus barotrauma. Hysterical perpetuation of barotraumatic symptoms was considered to be present in two of these and they are included in the eighteen cases mentioned above.

The differentiation of true sinus barotrauma from neuropsychiatric symptoms which simulate the syndrome is aided by an experienced examiner's observation of patients' reactions during a standard decompression test. Turner (1943) investigated twenty-five "doubtful" cases in a low-pressure chamber and his findings are shown in Table IV, which is modified from his report:

TABLE IV

FINDINGS IN 25 "DOUBTFUL" CASES OF SINUS BAROTRAUMA SUBJECTED TO THE STANDARD DECOMPRESSION TEST

Main symptoms in past flying history.	No signs No symptoms.	Otic baro- trauma alone.	Sinus and otitic baro- trauma.	Sinus baro- trauma alone.	Symptoms without organic basis.
Referable to sinuses ..	5	—	—	2	5
Referable to sinuses and ears	3	2	1	1	6
Total .. ..	8	2	1	3	11

Table IV demonstrates that of twenty-five possible cases ten showed no signs or symptoms of sinus barotrauma (i.e. the contributory factor had been a temporary one which had resolved), four patients developed true sinus barotrauma and in eleven the symptoms probably were psychiatric.

#### AIR-SICKNESS

Two patients who suffered from air-sickness were improved in this respect after surgical treatment of the affected sinus. Two others, who

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were returned to full flying duties after apparently successful treatment of the involved sinus, developed air sickness and were taken off flying duties by the neuropsychiatrist

### Symptoms.

As the purpose of the nasal sinuses is still unknown there is no recognizable loss of function in sinus barotrauma and pain is usually the only symptom. A few patients complained of lachrymation, a serous or bloody nasal discharge or of a "sucking noise high up" in the nose.

*Pain* was usually of sudden onset and of severe intensity during descent, and of more gradual onset and less severity when it occurred during ascent. In six cases it was so disabling that the trip had to be abandoned and two patients stated that the severity of the pain caused them to "lose consciousness". Although the pain frequently was felt to originate above and behind the eyes, it often spread over the vertex to the temporal regions and down the face to the upper teeth.

As a rule the pain continued from the time of onset until landing but occasionally it persisted or recurred on and off for some hours or several days.

Two patients stated that the pain was relieved by ascent and one by descent. Five patients complained that the pain was aggravated by nose blowing or by Valsalva's manoeuvre when "clearing" their ears.

Frequently a generalized headache which persisted for a varying period was present after cessation of the pain.

A number of patients experienced only one attack of pain. A few suffered from recurrent attacks on successive flights, but the majority developed the syndrome at irregular intervals throughout their flying career, and this intermittence was characteristic in this series.

Of one hundred and thirty-two patients of this series who exhibited some clinical and/or radiological abnormality of the nasal tract one hundred and twenty-four (93.9 per cent) complained of pain over one or both frontal regions, although only in fifty-one (38.6 per cent) was there any manifest lesion of the frontal sinuses. Thirteen patients with no discoverable nasal or sinus lesion complained of frontal pain, and one patient in whom X-ray showed a congenital absence of the left frontal sinus experienced pain over his left frontal region.

The situations in which the pain was felt and the probable sinuses of origin are shown in Table V.

These findings agree with the accepted views concerning referred pain in sinusitis but they are at variance with the opinion expressed by Behnke and Willmon (1941) that the pain of sinus barotrauma "serves to outline the involved area on the surface of the head and face making evident the diagnosis of maxillary, frontal or ethmoid sinusitis."

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In the majority of patients the pain occurred during loss of height, in some it arose whilst climbing or level flying, and in five who suffered from repeated attacks the onset of pain was during descent in the earlier

TABLE V

SITUATIONS IN WHICH PAIN WAS FELT AND PROBABLE SINUSES OF ORIGIN IN 145 PATIENTS

Clinical and/or radiological abnormality (Contributory factor and/or effect of barotrauma).	Situation of the pain.			Total.
	Over one frontal region.	Over both frontal regions.	Over one cheek.	
One frontal sinus .. .. .	21	6	—	27
Both frontal sinuses .. .. .	3	4	—	7
One frontal sinus and one antrum ..	4	5	1	10
Pansinusitis .. .. .	2	5	—	7
One antrum .. .. .	25	12	5	42
Both antra .. .. .	11	5	—	16
Uncomplicated rhinitis .. .. .	5	6	2	13
Deviated nasal septum .. .. .	7	3	—	10
No clinical or radiological abnormality ..	8	5	—	13
Totals .. .. .	86	51	8	145

flights and during ascent in the later ones. Three patients complained of pain immediately after landing which was probably caused by loss of height. In one case the pain occurred eight hours after landing—i.e. "delayed" sinus barotrauma.

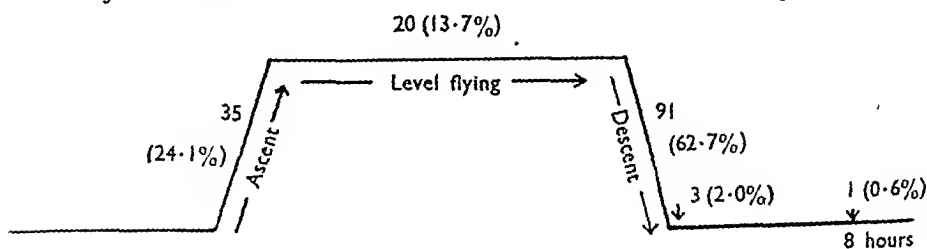


FIG. 3  
Relationship of onset of pain and phases of flight

The frequency of the onset of pain during the various phases of flight is shown in Table VI and Fig. 3.

A "sucking noise high up in the nose" was described by several patients. When present it usually preceded the onset of pain. This

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symptom is considered to be pathognomonic of submucosal hæmorrhage by Herrmann (1940)

*Lachrymation* and *nasal discharge* are described later

## Signs

Apart from radiological evidence signs of sinus barotrauma were very few as they were probably masked by those of the contributory factor

*Lachrymation* which caused involuntary closure of the eyelids and blurring of vision was complained of by three (2 per cent) patients

TABLE VI  
ONSET OF PAIN IN THE VARIOUS PHASES OF FLIGHT

A Descent 91 (62.7%) cases			
(1) Descent			81
(2) Loss of height of 10 000 ft or more			3
(3) Descent and later ascent			5
(4) Spinning			1
(5) Black out			1
B Ascent 35 (24.1%) cases			
(1) Ascent			9
(2) Ascent over specified heights			
6 000 ft	4	}	11
8 000 ft	1		
10 000 ft	3		
12 000 ft	1		
15 000 ft	1		
17 000 ft	1		
(3) Descent and later ascent (A (3))			5
C Level flying 20 (13.7%) cases			20
D After landing 4 (2.7%) cases			
Immediately	3	}	4
After 8 hours	1		

*Suffusion of the conjunctiva* has been described as a sign of sinus barotrauma, but it was not observed in any patients of this series

*Nasal discharge* Three patients had a copious non-purulent discharge from their nasal fossae during the attack—one stated that his nose "wept" and three patients, already described, had a hæmorrhagic nasal discharge. Gross hæmorrhage into the sinus cavities does not appear to be frequent—there was one proved case amongst the eighteen air crew cadets previously mentioned and one proved and three assumed cases in the present series. Purulent and muco purulent secretion was noted in a large number of patients

*Tenderness on pressure* on the floor of the frontal sinuses was present in a few cases

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*Transillumination* afforded evidence similar to that of ordinary rhinological investigation.

*Radiological examination* gave the most reliable information of the presence of a sinus lesion but, as a radiograph taken immediately before the flight was in no case available for comparison, it failed to differentiate contributory factors from the results of barotrauma or from some pre-existing coincidental lesion.

In one hundred and nine (75·1 per cent.) patients positive X-ray findings were reported as shown in Table VII. In thirty-six (24·1 per

TABLE VII  
RADIOLOGICAL FINDINGS IN 145 PATIENTS

X-ray finding (Contributory factor and/or barotraumatic change).	Antrum.	Frontal.	Antrum and frontal.	More than two sinuses.	Total.
Thickened mucosa .. ..	16	5	4	1	26
Thickened mucosa and polypi	1	—	—	1	2
Thickened mucosa and effusion .. ..	1	2	—	1	4
Polypi .. .. .	8	2	1	—	11
Effusion .. .. .	3	2	—	—	5
" Hazy " .. .. .	2	6	2	—	10
Hazy outline .. ..	—	3	—	—	3
Opaque .. .. .	27	14	3	4	48
Totals .. .. .	58	34	10	7	109

Radiologically negative	{ Clinically N.A.D. .. ..	13	36
	{ Uncomplicated rhinitis .. ..	13	
	{ Deviated nasal septum .. ..	10	
			145

cent.) radiological examination was negative, but in twenty-three of these clinical examination showed some abnormality.

## Histological Changes

Squadron-Leader A. C. P. Campbell, R.A.F.V.R., who has examined a few biopsy specimens has kindly recorded the following notes on the histological changes observed.

" Biopsy sections of antral mucosa have been examined in a few cases of recurrent sinus barotrauma. These have shown subacute or chronic inflammatory changes—marked œdema (to the degree in one

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case of microscopic cystic accumulations of fluid in the mucosa), congestion, small mucous and submucous hæmorrhages, plasma-cell, polymorph and lymphocytic infiltration of the mucosa, and a moderate degree of fibroblastic hyperplasia. But exactly similar changes may be found in the mucosa in subacute or chronic infective antritis where there has been no question of sinus barotrauma. So that in these few barotraumatic cases it seems probable that the histological appearances are those of a complicating infective antritis. From previous experience of the morbid histology of experimental otitic barotrauma one may suggest that some of the changes in the antral mucosa (the mucosal hæmorrhages for example, and the congestion and œdema) may be partly barotraumatic, but to what extent it is impossible to say.

In one case, however, histological changes were found which appeared to be purely barotraumatic (see case of Pilot Officer Sm quoted above). The affected area of mucosa containing the 'polyp' was excised and sectioned. The nodule was found to consist of a hæmatoma in the mucosa, five millimetres in diameter, encapsulated in densely collagenous fibrous tissue, and still undergoing rather sluggish organization. The surrounding fibrotic mucosa contained histiocytes laden with iron obviously a product of organization of the hæmatoma and/or of other smaller mucosal hæmorrhages. But there was no inflammatory infiltration to suggest an infective complication. The case is of interest in that it gives histological evidence (a) of the production of mucosal hæmorrhage by barotrauma, and (b) of the considerable time such hæmorrhage may take to be organized or otherwise removed.

### Possible Mechanism of Pathological Changes

The vascular changes can be explained by Figs 4, 5 and 6.

Fig 4 is a graph of the atmospheric pressures, and the changes encountered during an ascent from ground level (760.0 mm Hg) to 12,000 feet (483.2 mm Hg) are shown at A.

Assuming that the sinus walls are completely rigid and that the antral ostium is occluded by a polypus (P) on its sinus aspect as shown in Fig 5, on reaching 12,000 feet the pressure of the air within the sinus cavity (A) and of the tissue fluids of its lining (F) will be approximately 760.0 mm Hg, whilst that of the atmospheric air (AT) and of the tissue fluids (S and M) outside the antrum will be approximately 483.2 mm Hg—a difference of 276.8 mm Hg.

The blood vessels (C) of the antral mucosa (F) entering through the walls of the sinus have an absolute pressure in their capillaries of say 503.2 mm Hg (483.2 mm Hg atmospheric pressure plus 20.0 mm Hg hydrostatic pressure). There is therefore a difference between the pressure in the capillaries and that of the antral tissue fluid of 256.8 mm Hg—consequently a pressure ischæmia of the mucosa will be produced.

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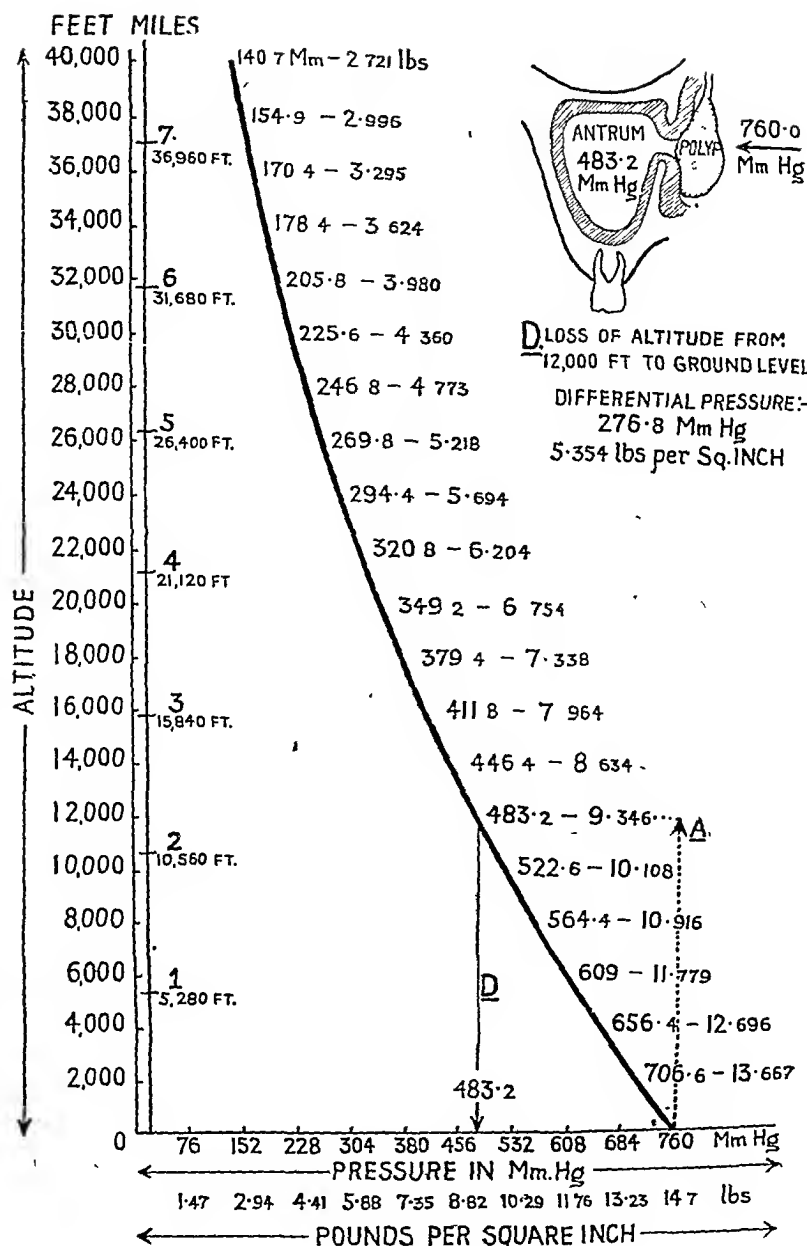


FIG. 4

Graph of atmospheric pressures.

- A. Ascent from ground level (760 mm. Hg) to 12,000 ft. (483.2 mm. Hg)—pressure difference 276.8 mm. Hg.  
D. Descent from 12,000 ft. (483.2 mm. Hg) to ground level (760 mm. Hg)—pressure difference 276.8 mm. Hg.

## Nasal Sinus Pain caused by Flying

If during descent (D, Fig. 4) from 12,000 feet (483.2 mm. Hg) to ground level (760.0 mm. Hg) the antral ostium is occluded by a polypus (P) in the nasal cavity as shown in Fig. 6, on reaching ground level the air pressure within the sinus cavity (A) and of the tissue fluids of its lining (F) will be 483.2 mm. Hg, whilst that of the atmospheric air (AT)

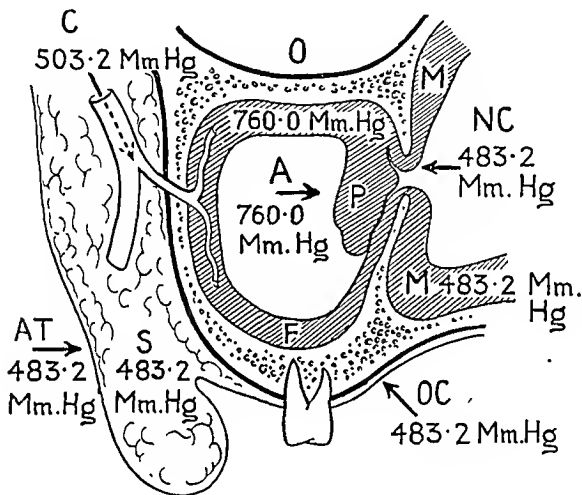


FIG 5

Diagram of antrum with ostium occluded by a polypus in the cavity after ascent from ground level (760 mm Hg) to 12,000 ft (483.2 mm Hg)

- A —Antral cavity
- F —Tissue fluids of antral lining
- AT —Atmosphere
- OC —Oral cavity
- NC —Nasal cavity
- P —Polypus
- S —Tissue fluid of cheek
- M —Tissue fluid of nasal mucosa
- O —Orbit
- C —Capillary entering antral cavity

and of the tissue fluids (S and M) outside the antrum will be 760.0 mm. Hg—a difference of 276.8 mm. Hg.

The absolute pressure in the capillaries of the blood vessels (C) entering the cavity is say 780.0 mm. Hg (760.0 mm. Hg atmospheric pressure plus 20.0 mm. Hg hydrostatic pressure). There is therefore a difference



# J. E. G. McGibbon

between the pressure in the capillaries and that of the antral tissue fluid of 297.8 mm. Hg. As a result of this difference the vessels become engorged so that mucosal oedema and hæmorrhage and effusion into the cavity may be produced.

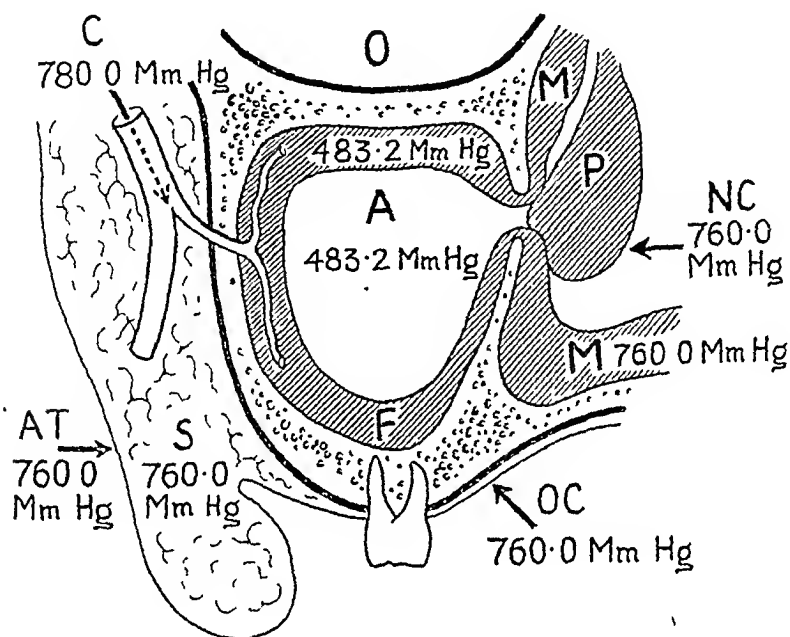


FIG 6

Diagram of antrum with ostium occluded by a polypus in the nasal cavity after descent from 12,000 ft (483.2 mm. Hg) to ground level (760 mm. Hg)

- A —Antral cavity
- F —Tissue fluids of antral lining
- AT —Atmosphere
- OC —Oral cavity
- NC —Nasal cavity
- P —Polypus
- S —Tissue fluid of cheek
- M —Tissue fluid of nasal mucosa
- O —Orbit
- C —Capillary entering antral cavity

## Prophylaxis

Although many individuals suffering from acute and chronic upper respiratory infections, established infective sinusitis and polyposis, fly without experiencing any ill effects, it is apparent from this analysis that the results of infection are the most frequent contributory factors in the production of sinus barotrauma; and it is undoubtedly the high medical standards required by the Royal Air Force which have reduced the incidence of sinus barotrauma to its present low level.

# Nasal Sinus Pain caused by Flying

In war it is impracticable to "ground" all air-crew personnel who complain of "colds", but in civilian and peace-time military aviation the inadvisability of flying whilst suffering from an upper respiratory infection is obvious.

## Treatment

### (A) IMMEDIATE TREATMENT

There has been no opportunity in this Hospital to carry out immediate treatment but this should be directed towards equalization of the sinus and atmospheric pressures either in aircraft or in a decompression chamber. From information received from Unit Medical Officers it would appear that such attempts are not so effective in this condition as they are in cases of acute otitic barotrauma, and when submucosal hæmatoma or of gross hæmorrhage into a sinus cavity have occurred, it is obvious that attempts to restore pressure equilibrium would be of no value.

The application of vaso-constrictors in the form of inhalations, sprays, drops or paints should be of assistance at this stage.

### (B) LATE TREATMENT

In hospital treatment has been largely that of the contributory factors and the initial disposal of the patients referred to hospital was as shown in Table VIII:

TABLE VIII	
INITIAL DISPOSAL OF 145 PATIENTS REFERRED TO HOSPITAL	
Refused treatment	7 (4.8%)
No treatment considered necessary	36 (24.8%)
Conservative treatment on Station advised	6 (4.1%)
Referred to Neuropsychiatrist	7 (4.8%)
Admitted to hospital	89 (61.3%)
Total	145

*Conservative treatment* was afforded to thirty-nine (26.8 per cent.) patients, including six treated on their Stations. It consisted of rest,

TABLE IX	
SURGICAL PROCEDURES PERFORMED ON 56 PATIENTS	
Removal of nasal polyp	2
Partial removal of middle turbinate and intranasal enlargement of fronto-nasal canal	13
Submucous resection of septum	8
Submucous resection and partial middle turbinectomy	2
Intranasal antrostomy	7
Intranasal antrostomy and partial middle turbinectomy	7
Intranasal antrostomy and submucous resection	1
Intranasal antrostomy, submucous resection and removal of polypus	1
Caldwell-Luc operation	14
External exploration of frontal sinus	1

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either in bed or on sick-leave and the usual rhinological therapeutic measures, sulphonamide drugs if infection was present or suspected, short-wave diathermy, lavage of the sinuses, etc.

*Surgical treatment* was carried out in fifty six (38.6 per cent.) patients and was mostly of a simple nature as shown in Table IX.

## Results of Treatment and Prognosis

The results of treatment and the prognosis may be assessed from a consideration of the final disposal of the patients as shown in Table X :—

TABLE X  
FINAL DISPOSAL OF 145 PATIENTS

Treatment.	Full flying duties.	Limited flying duties.	Referred to Neuro-psychiatrist.	Referred to higher authorities.	Transferred to other hospital.	Still under treatment.	Total.
Refused treatment ..	6	—	—	1	—	—	7
No treatment necessary	31	2	7	2	1	—	43
Conservative treatment	39	—	—	—	—	—	39
Surgical treatment ..	43	2	6	3	—	2	56
Totals .. ..	119	4	13	6	1	2	145

It will be seen from Table X that one hundred and nineteen (82 per cent.) patients returned to full flying duties, and four (2.7 per cent.) to limited flying duties.

One of six referred to higher authorities was placed on limited flying duties but the disposal of the remaining five is not known.

The average times off flying duty (including sick-leave) of the patients who returned to full and limited flying duties were as follows :

Refused treatment .. ..	4.2 days
No treatment .. ..	5.6 days
Conservative treatment .. ..	5.5 weeks
Surgical treatment .. ..	8.4 weeks

It is noteworthy that the case of proved submucosal hæmorrhage quoted in these notes had not resolved in five months, whereas Campbell (1944) states that "third degree aero-sinusitis" (i.e. "extensive swelling of the lining membranes, often accompanied by extravasation of blood into the cavity of the sinus or submucosal hæmatoma") resolves completely in "from 7 to 21 days".

# Nasal Sinus Pain caused by Flying

## Summary and Conclusions

(1) Pain of nasal sinus origin which sometimes is associated with other symptoms and/or clinical signs and which is attributable to flying, constitutes the syndrome of sinus barotrauma.

(2) The signs and symptoms are caused by changes of altitude (and atmospheric pressure) in the presence of some contributory factor which acts as a valve at the ostium of the affected sinus.

(3) The contributory factors may be developmental, traumatic, allergic, infective, neoplastic or any combination of these (Table I).

(4) The mechanical effect of such valvular formations is to bring about a difference between the pressure of the air contained within a sinus and that of the atmosphere; and no voluntary effort on the part of the patient will relieve or arrest the syndrome once it has been initiated.

(5) During ascent the relatively increasing pressure within the sinus cavity will cause an ischæmia of the mucosa. During descent there is a relatively decreasing pressure of the air content of the sinus which allows of engorgement of the mucosal capillaries and consequent œdema, hæmorrhage and/or effusion.

(6) One hundred and forty-five cases have been analysed in the preceding notes and these demonstrate that although sinus barotrauma is an entity it is not sharply defined owing to the following reasons:

(a) The most constant abnormal findings in the sinuses have been radiological (present in 75.1 per cent. cases), but X-ray has failed to distinguish cause from effect of barotrauma or from some coincidental lesion unassociated with barotrauma.

(b) As the diagnosis very frequently has to be made on subjective symptoms alone the syndrome lends itself to hysterical mimicry and perpetuation. In 12.4 per cent. of the patients of this series the symptoms were considered to be psychiatric.

(7) It is impossible to assess the incidence. In this Hospital the incidence has been one quarter that of acute otitic barotrauma.

(8) Acute and chronic infections of the upper respiratory tract appear to be the most frequent contributory factors. Table III (2, 3, 7, 8 and 9) shows findings consistent with infection in 71.7 per cent. of patients, but in this respect it also has been impossible to differentiate cause from effect or from some coincidental lesion.

(9) Age, flying experience, type of aircraft flown and the nature of air-crew duties are not contributory factors.

(10) 10.3 per cent. of the patients developed acute otitic barotrauma and 1.3 per cent suffered from air-sickness.

(11) Pain has sometimes been accompanied by lachrymation, "sucking noise" in the nose and/or a serous or sanious nasal discharge.

(12) During descent the pain was usually of sudden onset and severe intensity. During ascent as a rule the onset was more gradual and the

pain of less severity. Symptoms developed in 24.1 per cent. of the patients during ascent, in 13.7 per cent. whilst level flying, in 64.7 per cent. during descent and in 2.7 per cent. after landing. One patient who complained of symptoms eight hours after landing is regarded as a case of "delayed" sinus barotrauma (Table VI).

(13) The pain was felt in the frontal region in 94.4 per cent. of cases although only in 35.1 per cent. was there any radiological evidence of frontal sinus involvement (Table V).

(14) Clinical signs have been few and X-ray of the sinuses afforded the most reliable information. Positive radiological findings were present in 75.1 per cent. of cases (Table VII).

(15) In 8.9 per cent. of the patients there was no clinical or radiological evidence of contributory factor or of the results of barotrauma. 50 per cent. of these were considered to be psychiatric cases.

(16) The histological changes observed in a few cases have been indistinguishable from those of an infective sinusitis, except in one case of submucosal hæmorrhage.

(17) Prophylaxis comprises careful rhinological selection of aviators and the avoidance of flying whilst suffering from an acute or chronic upper respiratory infection.

(18) Treatment depends upon the time which has elapsed between the onset of symptoms and its application.

(a) If seen in the early stages, within a few hours after landing, equalization of the sinus and atmospheric pressure should be attempted in aircraft or in the low-pressure chamber. Vaso-constrictors applied to the neighbourhood of the sinus ostium might be beneficial.

(b) In the later stages, after twenty-four hours, treatment can only be expectant and any manifest contributory factor should be corrected. 61.3 per cent. of the patients of this series were admitted to Hospital and 38.6 per cent. were subjected to surgical procedures. (Tables VIII and IX.)

(19) The prognosis is favourable. 82.0 per cent. of the patients returned to full operational flying duties and 2.7 per cent. to limited flying duties. (Table X.)

(20) The time off flying duties varied from four and a half days to eight and a half weeks, except in the case of the patient with a proved submucosal hæmorrhage who did not return to duty for six months.

## Acknowledgements

My thanks are due to Squadron-Leaders G. F. Rees-Jones, E. H. Allen and R. F. Wynroe for their help and many excellent radiographs and to the Director-General, Royal Air Force Medical Services for permission to publish these notes.

# Nasal Sinus Pain caused by Flying

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## CLINICAL RECORD

### A CASE OF HÆMORRHAGE FROM AN ACUTE RETROPHARYNGEAL ABSCESS

By JOHN L. INSLEY (Oxford)

A WOMAN of 26, was admitted to the Radcliffe Infirmary on 16.10.44 with a history of an acute head cold a fortnight previously, which had been followed four days later by a sore throat with malaise and pyrexia. She had then been given sulphanilamide gm. i four-hourly for 48 hours, the dosage being reduced to gm. ss for a further 48 hours. At the end of this time she had been well enough to get up, but two days prior to admission she developed dysphagia of an increasingly severe order, with pain in the left side of her neck, and a swelling below the left ear.

On admission, her temperature and pulse rate were respectively 99.2 and 120. There was gross swelling of the left side of the posterior pharyngeal wall behind the posterior pillar, extending medially to the midline, and up and down from the oro-pharynx. There were scarred and infected tonsil relics both sides, and that on the left side was pushed downwards and medially by the swelling behind it. There was also a tender swelling of the neck, under the upper part of the sternomastoid, suggestive of a deep lymphadenitis. There were no other abnormal physical signs. X-ray of the cervical spine and W.R. were both negative. The blood count showed only a mild polymorphonuclear leucocytosis.

She was given sulphathiazole gm. iv, followed by a maintenance dose of gm. ii four-hourly, the presumption being that she had a retropharyngeal cellulitis. During the next three days the temperature and pulse rate both fell to normal levels and there was a diminution in the size of the swelling in the neck. The pharyngeal swelling remained the same. On the third day following admission she coughed up a small amount of blood, and the same day she developed complete left nasal obstruction, and a left sided Horner's syndrome. This bleeding recurred two and three days later, and the nasal obstruction became bilateral. Seven days after admission the pharyngeal tumour was much larger than at any time before, though the swelling in the neck had materially subsided. Laryngeal and post-nasal examination of the pharynx revealed no ulceration of the tumour mass. Later in the same day she had a brisk secondary hæmorrhage, and died within a few minutes in spite of all attempts to re-establish an airway.

*Post-mortem* examination showed a retropharyngeal abscess of about 10 c.c. capacity, in relation to the nasopharynx, which opened by a tiny perforation into the internal carotid artery, and by a hole about 1 cm. in

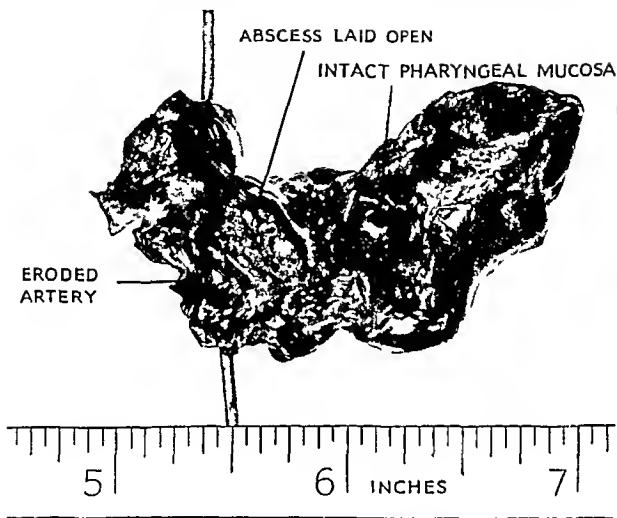


FIG. 1

Specimen of the posterior pharyngeal wall showing the abscess on the left hand side and with a rod through the internal carotid artery. The rod can be seen in the wall of the abscess where the latter has eroded the artery.





## Clinical Record

diameter into the pharynx, behind the soft palate. Death was apparently due to initial syncope, followed by massive aspiration of blood into the lungs.

This complication of retropharyngeal abscess was first described by Liston<sup>1</sup> in 1843, but has received scant attention in this country since then. A large number of cases have been described by American authors, notably Salinger and Pearlman<sup>2</sup>, who collected 231. According to them, secondary hæmorrhage usually arises from the internal carotid artery, though a branch of the external carotid is involved in a significant proportion of their cases. Smith<sup>3</sup> points out that bleeding may very rarely arise from the vertebral artery, though this possibility can for practical purposes be ignored. Lifschutz,<sup>4</sup> in an analysis of 21 cases, states that 12 occurred following drainage of the abscess, and 9 occurred spontaneously, but these figures are meaningless without the totals of cases treated, and it would seem, on *a priori* grounds, reasonable to suppose that hæmorrhage would be less common in those cases in which drainage had been carried out.

The most satisfactory form of treatment is ligation of the common carotid, both because it is certain to cover all types of hæmorrhage, and also because, owing to the anastomotic branches of the external carotid, it is less likely to produce hemiplegia than ligation of the internal carotid alone. Richards<sup>5</sup> points out that by the same token as this operation lessens the risk of hemiplegia, it may also fail to check bleeding, and continued hæmorrhage after it may necessitate a ligation of the external carotid.

The moment to undertake ligation is difficult to decide. Massive hæmorrhage is, of course, an immediate indication, the bleeding being checked by digital pressure on the carotid pending transport to the theatre, and there are a few cases on record of this measure being carried through successfully, e.g. <sup>6</sup>. For the rest, Havens<sup>7</sup> gives as relative indications warning hæmorrhages increasing size of the retropharyngeal swelling and a plum coloration thereof.

The first two of these in association probably constitute an absolute indication for ligation, especially if the increase in size of the swelling is not related to a general systemic deterioration suggestive of a spread of infection. Warning hæmorrhage is almost an absolute indication in itself, and by its repetition becomes more and more compelling. A plum coloration of the tumour suggests a false aneurysm, which can be confirmed by aspiration, though this may be due to bleeding from small vessels into the abscess, and is not therefore of itself an indication for ligation. All these three signs were present in our case, though the third was not noted at the time, and its significance not realized. I would add to these the development of a Horner's syndrome as evidence that the carotid sheath has become involved in the pathological process, and though this does not mean that ligation is immediately necessary, it must constitute a serious warning. With these guides in mind, it should be a matter of only moderate difficulty to assess each case on its merits, and balance the risk of fatal hæmorrhage against that of the operation, namely, hemiplegia.

My thanks are due to Mr R G Macbeth, Otolaryngologist to the Radcliffe Infirmary, for permission to publish this case, and to Dr A H T Robb-Smith,

# John L. Insley

Director of Pathology to the Hospital, for allowing me access to the *post-mortem* records, and to Miss Foley for the photograph.

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## CLINICAL NOTES

### TREATMENT OF CARCINOMA OF THE VOCAL LIP BY OPERATION

By NORMAN PATTERSON (London)

It appears that the majority of laryngologists favour irradiation rather than surgery in the treatment of cancer of the larynx

I am one of those who consider that both methods still have their uses. Total laryngectomy is one of the most mutilating operations in the whole realm of surgery but there are cases where the operation is justifiable. When the disease is limited to the lip of the true vocal fold—the term vocal cord should be discarded as it suggests a string and gives an entirely wrong impression of the structure—surgical removal is so safe, the results are so brilliant, a permanent cure being the rule rather than the exception, that all the pros and cons should be most carefully considered before deciding on irradiation.

I intend to confine my remarks to cases where the disease is limited to the vocal lip. Where the lip is movable or where movement is only slightly impaired I do not think there is any advantage in resecting even a portion of the thyroid ala on the affected side. I have somewhat modified the classical operation which I shall not describe in detail. In my opinion regional anaesthesia should be employed whenever possible.

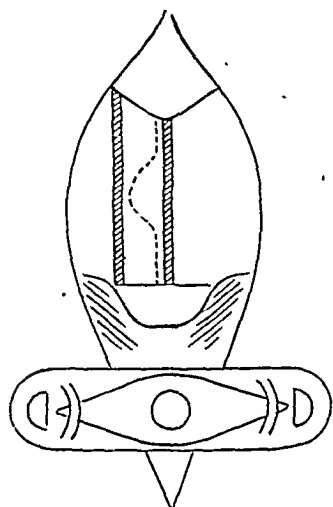
Many years ago I gave up the incision in the mid-line of the neck. The method I employ is as follows: it allows of a flap in the region of the larynx. The incision begins in the middle-line immediately above the thyroid cartilage and is carried outwards to right or left—a matter of no importance—and gradually curved downwards till it reaches the middle of the posterior border of the thyroid ala, it then curves downwards and forwards reaching the middle-line at the lower border of the cricoid cartilage, from this point it passes downwards in the middle-line as far as the supra-sternal notch.

The larynx, thyroid isthmus, and trachea are exposed in the usual manner. It is sometimes possible, after dividing transversely the fascia passing upwards from the isthmus of the thyroid gland, to dislocate the isthmus downwards so that a sufficient area of the trachea is available for a tracheostomy. In other cases the thyroid isthmus must be divided between ligatures.

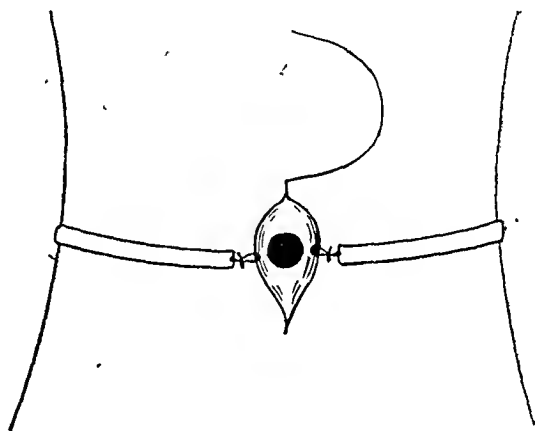
A disc is removed from the anterior wall of the trachea leaving an opening sufficiently large to accommodate the tracheotomy tube. Through this opening a marine sponge of fine texture, tethered to a strand of silk, is inserted in order to plug the crico-tracheal tube above the tracheotomy wound. The tracheotomy tube is now inserted.

In opening the larynx the customary method is to cut through the anterior angle of the thyroid cartilage and underlying mucous membrane with a pair

of special shears, but as the disease often approaches or even reaches the anterior commissure I prefer the following method. The thyroid cartilage which may be ossified is cut or sawn through in the middle line avoiding injury to the underlying soft tissues. A parallel incision is then made about a quarter of an inch from the central incision through the thyroid cartilage on the non-affected side of the larynx, care again is taken not to injure the soft tissues. The small linear portion of thyroid cartilage lying between the incisions is removed. An incision is now made in the middle line through the soft tissues with a diathermy needle. It commences at the upper border of the cricoid and is carried upwards but not so far as the attachment of the vocal lip. By employing slight retraction to the sides of the opening into the larynx the growth can be inspected and its anterior limits ascertained.



Semi-diagrammatic



Semi-diagrammatic

If the disease is sufficiently far from the anterior commissure the division can be carried upwards in the middle-line. If on the other hand the tumour encroaches on the anterior commissure the incision must be made to deviate from the middle line so that a small portion of the non-affected vocal lip is removed; above this point the incision again passes towards the middle line. In this way the larynx can be opened without any danger of cutting into the tumour and without any bleeding. The two sides of the larynx are now held apart by retractors and another marine sponge is inserted above the one previously placed in position; it should be a little larger than the lower sponge.

Removal of the tumour with an ample margin of healthy tissue is accomplished in the usual way after elevating the soft tissues from the inner aspect of the thyroid plate. Any bleeding vessel met with in the arytenoid region can be grasped with forceps and diathermy applied to the shaft of the forceps. The patient's head should now be flexed and he is asked to cough several times. If no bleeding occurs the tracheotomy tube is removed and then the sponges by grasping them with forceps. It is not advisable to pull on the silk strings. On one occasion the string pulled away from the lower sponge which got loose

## Clinical Notes

in the trachea ; fortunately it was removed before being sucked down. After the removal of the sponges the patient is again requested to cough vigorously.

If hæmostasis is entirely satisfactory the tracheotomy tube may be removed at the end of the operation, but in this case a stitch attached to a tape should be inserted through the strap muscles on each side. The tapes can be tied together at the back of the neck so as to exert enough tension to keep the wound open. The flap is stitched in position so that it covers the wound in the thyroid cartilage. When a small portion of the arytenoid cartilage, represented usually by the vocal process only, has been removed for some days difficulty in swallowing may be experienced and fluid may trickle into the larynx and come out through the tracheotomy wound or passing downwards into the trachea cause coughing ; there is a risk of infection of the lower air passages. In order to avoid this the patient should lie prone and suck up fluid nourishment through a glass tube (Wolfenden position). I have not seen this position advocated as a post-operative procedure. The position should be maintained for some time after swallowing acts have ceased as fluid may continue to trickle from the tracheotomy wound.

Some surgeons recommend carrying out operations of the nature described without performing tracheotomy. A small stiff endotracheal catheter with an inflated cuff has been employed in order to prevent blood and secretions passing downwards.

I consider that a tracheotomy entails no extra risks at the time, allows complete insurance against the passage downwards of blood or saliva and, in the event of post-operative bleeding, the presence of a tracheotomy opening may, as I myself have experienced, save the patient from catastrophe. The tracheotomy opening should be allowed to close as soon as the danger of post-operative hæmorrhage is past and any swallowing difficulties have been overcome.

I am greatly indebted to Dr. Loftus-Dale for valuable help and I am now of the opinion that whenever possible regional anæsthesia should be employed in operations involving the neck more especially when the respiratory passages are concerned. I have carried out many operations when Dr. Dale has prepared the field, including such extensive procedures as block dissections of the neck and I am inclined to think that by avoiding inhalation anæsthesia, the post-operative mortality risk is much diminished. Recently, I operated on a patient of 75 for cancer of the larynx ; the general disturbance was remarkably slight and recovery was rapid.

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## H. W. Loftus-Dale

short time during the operation, dropping to 80 again before the end and remaining the same after his return to bed, he had had his true and false vocal fold removed on the left side. Recovery was uneventful.

### Conclusion

A technique for regional analgesia for "laryngofissure", for which no originality is claimed, is described. It has proved safe and satisfactory in a small series of cases which were considered to be unsuitable for G.A. It is not suggested that it should be used as a routine in intrinsic growths of the larynx, but that in certain poor risk cases it is the method of choice.

I am indebted to Mr. Norman Patterson for his help and encouragement in this work.

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# The Journal of Laryngology and Otology

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*December 1944*

## A SURVEY OF THE AURAL HEALTH OF AIRCREW CANDIDATES FOR SERVICE WITH THE ROYAL AIR FORCE

By, Air Commodore E D D DICKSON, R A F and  
Wing Commander G H BATEMAN R A F V R (London)

THE standard of general fitness demanded from aircrews is very high. This applies to no less extent to aural fitness. Heights attained, speed, and manœuvrability of modern aircraft, the use of telecommunication and other wireless devices, demand a high degree of aural efficiency.

The present survey is based on an examination of 285,018 candidates presenting themselves at Royal Air Force Aviation Candidates Medical Boards, for aircrew duties. All candidates for presentation at these boards have been previously examined by National Service Medical Boards instituted under the Military Training Act and have been previously placed in a Grade I or Grade II (a) Feet category with hearing standard I and visual standard I or II. The only exceptions to this are serving airmen who joined the R A F before the war and a very small number of University candidates. This survey covers males between the ages of 18 and 32 years, who have volunteered for aircrew duties. It is suggested that the results of these examinations give a fair indication of the aural health of a cross section of the young adult male population of the United Kingdom who are not aware of any aural disability. There is no detectable difference in the figures drawn from the different geographical areas of the United Kingdom.

Considerable aural defects may be placed in Grade I by the recruiting Medical Boards in accordance with M R B 1 paras 17 and 18. M R B 1 is the instructions for the guidance of Medical Boards under the National



## ANÆSTHESIA FOR LARYNGOFISSURE

By H. W. LOFTUS-DALE (Aylesbury)

It is generally accepted that in cases of malignant disease of the larynx surgery offers the best treatment. Opinion is divided concerning the relative merits of general anæsthesia and regional analgesia for the operation of "laryngofissure," but in recent years new agents and perfection in technique have turned the scale in favour of general anæsthesia. The purpose of this article, based on a small series of poor risk or senile cases in which general anæsthesia was considered to be too risky, is to point out that there is still scope for regional methods.

Operations on the larynx itself were regarded by Magill<sup>1</sup> as a contra-indication to endotracheal anæsthesia, but since then a technique has been described<sup>2</sup> which is claimed to obviate the necessity for a tracheotomy and insure against the dangers of aspiration in the immediate post-operative stage by the use of an endotracheal tube fitted with inflatable cuff passed nasally, surface analgesia and injections of morphia being employed to enable the patient to tolerate the presence of the tube.

When the operation is performed under a regional analgesia the surgeon is given good access and the ability of the patient to co-operate by coughing if required, is helpful, and there is no period between the time the patient can guard his tracheo-bronchial tree against the dangers of aspiration and that when this is done for him by mechanical means. The tracheotomy is not a great added inconvenience to the patient, since it is a very temporary measure and soon closes; in any case the patient would not be allowed to attempt to speak.

The only contra-indication to regional anæsthesia would appear to be reluctance on the part of the surgeon to inflict, or of the patient to endure, what must usually be a somewhat unpleasant ordeal, which however may not be so bad as imagined since one of our patients who had a general anæsthetic administered by an expert for the biopsy, said that he much preferred the regional which he had for the operation.

### Premedication

Since central respiratory depression must be avoided, morphia should not be used, indeed it is highly dangerous<sup>3</sup>. Pentobarbital sodium ("Nembutal") grs.  $1\frac{1}{2}$  was found, in practice, to provide a reasonable degree of sedation and, in theory, afford protection against some of the harmful effects of cocaine and its substitutes. Pethidine (Roche) syn. Demerol<sup>4</sup>, Dolantin, combines some of the analgesic effect of morphine with the spasmolytic and drying effect of atropine and in the dose used (50 mg.) did not cause respiratory depression.<sup>3</sup> It is also useful in the early post-operative period.

# Clinical Notes

## Technique

(i) *Block of superior laryngeal nerves*<sup>5</sup> The patient is placed supine on the table with a small pillow under the shoulders in order to produce moderate extension of the neck and to render the hyoid bone more prominent. Lateral pressure from the opposite side will facilitate palpation of the great cornu, 1 cm inferior and 2 cm anterior to which a wheal is raised with a fine intradermal needle, a 5 cm needle is inserted through the centre of this wheal and advanced in an upward and backward direction towards the cornu passing between the thyro hyoid muscle and membrane. In order to avoid penetrating the great vessels the point of the needle must not go beyond a line joining the great cornu of the hyoid with the superior cornu of the thyroid. If paræsthesiæ are elicited, the syringe is connected without displacing the needle, the aspiration test performed and 2 c c of the solution injected very slowly as laryngeal spasm might result from rapid submucosal injection should the thyroid membrane have been penetrated<sup>6</sup>. In the absence of paræsthesiæ, 1 c c is injected about 0.5 cm below the cornu and the remainder as the needle is being withdrawn.

Paræsthesia can be detected by watching the patient's expression or by some pre arranged signal. The patient should be told not to speak or swallow during the procedure.

The solution used was an ampoule made for me by Messrs Glaxo Laboratories Ltd and contains 40 mg procaine hydrochloride, 2 mg "Anethaine" and adrenalin 1,400,000<sup>7</sup>.

(ii) *Field Block* Starting from the original two wheals a field block is induced bounded superiorly by the hyoid bone laterally by the anterior borders of the sternomastoids and inferiorly, by the suprasternal notch. This avoids the anatomical distortion caused by infiltrating the line of incision as well as providing an adequate area of analgesia. I have also found a superficial cervical plexus block to be very satisfactory. About 20 to 30 c c of "Anethaine" 1 4 000 adrenalin 1 400 000 is required for the field block.

(iii) *Analgesia of the Mucosa* A needle is introduced in the mid line through the crico thyroid membrane to a depth of about one centimetre the position of the point in the airway is verified by the feeling of free movement which is imparted and by the ease with which air can be aspirated, 2 c c of 10 per cent cocaine are injected very slowly drop by drop 1 c c with the head extended and one with the head flexed in order that both the tracheal and laryngeal portions of the mucous membrane may be reached by the solution the patient should be warned not to swallow during this manoeuvre.

Fifteen minutes should be allowed before making the incision, the sustained action of "Anethaine" allows ample time for the operation. So effective is the analgesia of the mucosa that packing with a piece of marine sponge does not evoke a cough the patient however, can cough when requested to do so.

In spite of the light premedication one patient fell asleep for a short time during the operation.

There have been no post operative complications. In the case of one man of 75 years of age, the pulse was 80 on arrival at the theatre, rose to 90 for a

short time during the operation, dropping to 80 again before the end and remaining the same after his return to bed, he had had his true and false vocal fold removed on the left side. Recovery was uneventful.

### Conclusion

A technique for regional analgesia for "laryngofissure", for which no originality is claimed, is described. It has proved safe and satisfactory in a small series of cases which were considered to be unsuitable for G.A. It is not suggested that it should be used as a routine in intrinsic growths of the larynx, but that in certain poor risk cases it is the method of choice.

I am indebted to Mr. Norman Patterson for his help and encouragement in this work.

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## A SURVEY OF THE AURAL HEALTH OF AIRCREW CANDIDATES FOR SERVICE WITH THE ROYAL AIR FORCE

By, Air Commodore E D D DICKSON R A F and  
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THE standard of general fitness demanded from aircrews is very high. This applies to no less extent to aural fitness. Heights attained speed, and manoeuvrability of modern aircraft, the use of telecommunication and other wireless devices, demand a high degree of aural efficiency.

The present survey is based on an examination of 285,018 candidates presenting themselves at Royal Air Force Aviation Candidates Medical Boards, for aircrew duties. All candidates for presentation at these boards have been previously examined by National Service Medical Boards instituted under the Military Training Act and have been previously placed in a Grade I or Grade II (a) Feet category with hearing standard I and visual standard I or II. The only exceptions to this are serving airmen who joined the R A F before the war and a very small number of University candidates. This survey covers males between the ages of 18 and 32 years, who have volunteered for aircrew duties. It is suggested that the results of these examinations give a fair indication of the aural health of a cross section of the young adult male population of the United Kingdom who are not aware of any aural disability. There is no detectable difference in the figures drawn from the different geographical areas of the United Kingdom.

Considerable aural defects may be placed in Grade I by the recruiting Medical Boards in accordance with M R B 1 paras 17 and 18. M R B 1 is the instructions for the guidance of Medical Boards under the National

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Services (Armed Forces) Act. In para. 17 under the heading "otitis media and discharge from the ear" this sentence appears: "Where it is considered that the infection is confined to the middle or external ear grading will be decided with due regard to the condition of the nose and throat, the liability to recurrence, and the standard of hearing." Para. 18, standards of hearing, reads: "Standard I—A man can hear a soft whisper with each ear separately. When testing, the examiner should himself occlude the ear not being tested and whisper towards the ear. Standard II hearing is less than Standard I but the man, standing with his back to the examiner and using both ears, can hear a forced whisper from 10 feet away." This allows men with standard II hearing to be placed in Grade I even though they may have open perforations of the tympanic membrane or an active otitis media with a central or anterior perforation. Thus considerable resentment is encountered in candidates who come to an Aviation Candidates Medical Board as Grade I and are not only rejected for aircrew duties, but are also down graded or even rejected for all R.A.F. duty. The R.A.F. do not accept the Ministry of Labour categories for chronic otitis media, active or quiescent. In the R.A.F., all cases of dry perforation of the tympanic membranes are categorized Grade III, and all cases of active otitis media which cannot be made dry by conservative treatment are recategorized Grade IV. It must be realized that the only home service category for serving airmen is Grade III and it is the R.A.F. practice not to allow men with perforated tympanic membranes to serve overseas.

This big discrepancy between R.A.F. standards (described later) and the National Service standards causes serious disappointment to many keen volunteers and equalization of the standards would confer great benefit to all concerned. Rejected candidates have difficulty in understanding that neither the National Service Board nor the R.A.F. Aviation Candidates Medical Board have made a mistake and therefore continue their search for a scapegoat. Experience during this war has confirmed the Department of Otorhinolaryngology in their opinion that the R.A.F. standards provide a more efficient working basis for the R.A.F. than the standards laid down in M.R.B.I. A large proportion of the invalids in the R.A.F. repatriated to the United Kingdom from the Near and Far East consist of cases of chronic otorrhoea. Under the conditions of service in these theatres very few perforations of the tympanic membrane remain stable. These cases cannot tolerate the introduction of moisture through the perforation and the external auditory meatus is frequently moist in the hot overseas climates. Swimming is a frequent contributory cause. Excessive sweating also leads to a moist condition of the meatus and the introduction of sand and dust may lead to a severe external otitis, or to a mild external otitis which is of little importance when the subject has an intact tympanic membrane, but which causes

# Survey of the Aural Health of Aircrew Candidates

an otitis media when a perforation is present. Chronic otorrhœa therefore occurs and is not easily controllable, so that the sufferers usually have to be invalided home. The difficulty in controlling these cases is due partly to the inaccessibility of specialist treatment and partly to the fact that any chronic sepsis responds badly to treatment under the physical conditions in these theatres.

The aural standards for acceptance of candidates at Aviation Candidates Medical Boards for training as aircrew are the same for all aircrew duties (pilot, observer, air gunner, etc.). These standards are —

*Hearing*—20 ft. forced whisper with each ear separately. Variations in the technique of testing hearing existed in the past and the results were often so controversial that some form of standardization was attempted as follows —

- (1) The candidate stands with the ear under test turned towards the examiner and at a distance of 20 ft.
- (2) An orderly facing the candidate places his right hand on the side of the candidate's face when testing the left ear so as to—(a) steady his head, (b) shield his eyes to prevent lip reading.
- (3) He inserts the middle finger of his left hand in the candidate's external auditory meatus and lightly shakes the finger in a way a violinist obtains a tremolo. The examiner then whispers the test words.
- (4) The candidate is turned round and the procedure is reversed when the other ear is tested.

The object of this is to produce a masking effect in the ear which is not under test. This ensures that each ear is tested individually and the response obtained is a nearer measure of any true impairment, if any, present than previous diverse methods. Under no circumstances is the candidate asked to occlude his own ear, for obvious reasons. The selection of words used and their presentation has been standardized. Figures are only used as an introduction, but low pitched words and high pitched words are used to estimate the candidate's ability to hear and the degree and type of any auditory defect encountered.

*Otoscopic appearances*—The tympanic membrane must be without perforation and the middle ear healthy. Active, quiescent, or inactive chronic suppurative otitis media with patent perforation are causes for rejection. Scarring of the tympanic membrane is not a cause for rejection, unless gross adhesions, which would suggest possible difficulty of middle ear ventilation are present. A healed perforation is not a cause for rejection unless it is very large and covered only with an atrophic epithelial layer. In all these types of healed chronic suppurative otitis media the degree of hearing loss governs the acceptance or rejection of the candidate with the previously mentioned exceptions. The clinical

estimation of scarring which may affect flying efficiency is left to the judgment of the examining specialist.

Patency of the eustachian tubes is essential for efficient flying. All candidates are examined for this by auto-inflation whilst the tympanic membrane is watched. Patency is demonstrated by seeing the membrane move or by listening with an auscultation tube. If the candidate hears normally it is assumed that his eustachian tube is functionally patent on the ground and testing the patency is carried out to obtain confirmatory evidence. Failure to auto-inflate is commonly due to failure to perform the manoeuvre correctly and not to any defect in the eustachian tube. Incidentally auto-inflation is a valuable aid to the diagnosis of small perforations.

Where deafness is suspected, tuning forks are used to confirm the deafness and to determine the type. These cases are rejected except in rare instances of real doubt when they are referred to the Consultant for audiometry. The doubt arises most commonly in those to whom English is not the native language as there is a considerable psychological factor in interpretation of the whisper near the threshold.

The examination at R.A.F. Aviation Medical Boards is always carried out by medical officers with training in this type of work. The minimal requirement for these officers is six months' previous appointment as House Surgeon or clinical assistant in a recognized Ear, Nose and Throat Department. Very few of these officers have been of specialist status though most of them had done considerably more than the minimum required and many of them intend to continue as Ear, Nose and Throat specialists and are therefore keen and anxious to observe and learn all they can of Ear, Nose and Throat work. It would be fair to say that the majority had not the clinical background required for making the diagnosis in difficult cases of deafness, though their observations and descriptions are as accurate as the examination room conditions allow.

The examination is carried out in a room usually 20 ft. long. The rooms are not consistently quiet. The amount of noise varies in the different boards and in the same board from time to time. Conditions are therefore neither standard in the same board from time to time nor from board to board. This is without doubt a source of error as on busy days it is impossible to wait for a quiet period in the passing traffic, and the examiner has to guess that the patient hears normally, for it must be remembered that 96 per cent. of all candidates have no obvious hearing defect.

Equipment provided allows for full consulting room investigation and facilities exist at most boards for radiography of the sinuses. Transillumination lamp, electric auriscope, tuning forks and Siegle's pneumatic speculum are provided. Examiners are encouraged to use the Siegle's speculum in all cases.

# Survey of the Aural Health of Aircrew Candidates

The organization of the medical board allows an average of five minutes for each ear, nose and throat examination. The past medical history has previously been taken. A complete examination takes about three minutes in a straightforward case, but about every fourth candidate has to have wax removed from his ears before an uninterrupted view of the membrane can be obtained. In two out of three cases this can be done with forceps, and the remainder have to be syringed. Thus every twelfth case has to have his ear syringed. The standard of hearing required and method of carrying out hearing tests have already been described. An idea has sometimes been expressed that a perforation of the tympanic membrane and a meatus obstructed with cerumen do not co exist. This is not borne out by the experience of the Medical Boards, and is completely without any factual foundation.

It is thought that it is exceptional for visible aural defects to escape notice and a candidate be unintentionally passed fit for aircrew. On the other hand, minor defects of auditory acuity can and do easily escape detection and only come to light when difficulties arise during training. Thus the only appreciable error in the attached figures is likely to be an underestimate of the number of candidates with an auditory defect and normal tympanic membranes (Table I, section D, iv).

The figures presented here are collected from 11 R A F Aviation Candidates Medical Boards. Approximately twenty medical officers with specialist training carried out all these examinations. Each board renders a two-weekly return in which the percentages are worked out. These percentages show an amazing constancy from board to board and period to period over a number of years. There is no appreciable variation in the results obtained by the different medical officers, nor has the proportion of candidates with aural defects discovered at these boards decreased with the increasing experience of the National Service Boards.

It will be seen that 1,640 of the candidates had an active chronic otitis media. These would all be rejected for all forms of R A F service. If already serving airmen, they would be treated conservatively and the permanent grading be fixed according to the aural condition on the completion of treatment.

1,306 candidates had dry perforations. These men would all be placed in Grade III.

The 4,528 candidates with loss of hearing but without a perforation of the tympanic membrane would be graded according to the auditory acuity except for those men with a progressive type of deafness. These cases of progressive deafness are not taken for R A F service when recognized though many are accepted because the progressive nature of the deafness is unrecognized at the first examination.

The 587 men with normal hearing but gross scarring of the membranes



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would be placed in Grade I unless the examining officer considers that they are subject to recurrent otorrhœa when they would be placed in Grade III. They are rejected for aircrew because it is thought that the adhesions of and the past damage to the tympanic membrane are such that equalization of the intratympanic pressure during ascent and descent would be interfered with. It must be realized that a large number of men are accepted for aircrew duties in spite of obvious scarring of the tympanic membranes. These men perform their duties satisfactorily and no excessive proportion of them has to be taken off flying later because of aural trouble.

TABLE I

## ANALYSIS OF EAR, NOSE AND THROAT REJECTIONS AMONG AIR CREW CANDIDATES EXAMINED AT ROYAL AIR FORCE AVIATION CANDIDATES MEDICAL BOARDS

A. Total examined .. .. .	285,018
B. Total cases permanently rejected for any cause including ear, nose and throat .. .. .	42,095
C. Total permanent ear, nose and throat rejects .. ..	8,944
D. Total permanent ear rejects .. .. .	8,068
i. Active chronic otitis media with perforation .. ..	1,640
ii. Dry perforations :	
Hearing up to aircrew standard (20 ft. F.W.) ..	585
Hearing below aircrew standard .. ..	721
iii. Old healed otitis media with scarring and/or adhesions but without perforation :	
Hearing up to aircrew standard (20 ft. F.W.) ..	587
Hearing below aircrew standard (20 ft. F.W.) ..	1,188
iv. Deafness with intact tympanic membranes (i.e. showing none of the changes defined in 1, 2, and 3) .. ..	3,340

### E. General remarks :—

The Ear rejects constitute 90.2% of E.N.T. rejects and of this  
 20.3% have active C.S.O.M.  
 16.1% have dry perforations.  
 22.0% have healed otitis with scarring.

E.N.T. rejects constitute 21.2% of total rejects for all causes and 3.1% of total examined.

Total permanent rejects for all causes constitute 14.8% of total examined.

41.4% of total permanent ear rejects have deafness with intact tympanic membranes.

## BLAST INJURIES OF THE EAR

By MAJOR D. H. CRAIG, R.A.M.C. (Belfast)

THIS paper is compiled from notes made on patients suffering from Blast Injuries of the Ear, examined in various parts of the world from 1939 until the present day. The mode of production of the blast varied under different conditions of warfare, but no relationship could be traced between the causal weapon and the injury sustained. The fifty-six cases analysed were seen recently: they were nearly all battle casualties and included not only British troops, but also Indian, Greek, Polish, Yugo-Slav personnel, and German prisoners of war. Though few in number, they illustrate the effects of blast on the human ear which the Army Otologist is called on to treat.

Of these cases, twenty-five were middle-ear injuries, twenty-three inner ear injuries, and eight were hysterical. Of the middle-ear injuries, nineteen patients had one ear only injured, and six had both. Fourteen were infected when first seen; they had been injured at periods varying from seventeen days to four years previously; one, injured six weeks before examination, had a mastoid infection which required operation.

Otorrhœa was the commonest symptom, only nine complained much of deafness, and of these, three had a fairly severe hearing loss, and were probably cases of associated injury to the inner ear.

Of the inner ear injuries, five patients were severely deafened, and these were distinguished from eight cases suffering from hysterical deafness by means of the cold caloric test. Of the remaining eighteen inner ear injuries, seven were slight in degree whose main complaint was tinnitus, and eleven had moderate degrees of inner ear deafness, who complained of varying degrees of deafness.

### Classification of Cases

Blast injuries of the ear may conveniently be considered in three groups:—

1. The injury mainly affects the middle ear.
2. The injury mainly affects the inner ear.
3. Hysterical deafness.

It is not possible to make a precise distinction between the groups. The inner ear may be involved when the middle-ear injury is more obvious, and there may be a functional element present in either. Malingering is very rare.

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## Symptoms

It is on account of deafness, tinnitus, bleeding, or discharge from the ears that the patient most often seeks advice. - Pain is rarely felt, though a sensation of something going "crack" in the ears is not uncommon. Vertigo is unusual, though it does occur. A soldier may complain of being dizzy after an explosion, when he will be found to mean, if carefully questioned, that he was dazed.

The deafness varies in severity. It may be absolute for months, with the patient apparently unable to hear any sound at all; it may persist for a few days only and then largely recover: or it may be so slight and transient, that no complaint of difficulty in hearing is made at all unless the soldier is directly questioned.

The tinnitus is inconstant in degree. It may never be a prominent feature, or for a short period just after the explosion may be so loud and roaring that the patient is quite dazed and confused. It may persist in the ear most affected for a long time, though tending to get less distracting as time goes on. It bears no relationship to the hearing loss. If the bleeding from the ear has not been so profuse as to run down the cheek it may escape notice. Perhaps the commonest history is for the patient to relate that he did not realize anything was the matter with his ears, until a profuse painless discharge began several days after the explosion. This is especially liable to be the case where other injuries had been sustained, or where the hearing loss is not severe.

## Injuries mainly affecting the Middle Ear

In a recent injury it is difficult at first to make out the landmarks. The tympanic membrane, bluish black in colour, due to blood in the middle-ear cavity, is mottled by flame-shaped hæmorrhages, especially along the handle of the malleus, and round the perforation. In the course of a few days, the hæmorrhagic areas assume a maroon shade, the colour of the drum fades, and dilated vessels may be seen running through its substance—one, constantly noticed, runs horizontally forward in the posterior quadrant along the course of the chorda tympani nerve. The edges of the perforation become more sharply defined, and the exposed mucosa of the middle ear, which is at first very red, remains hyperæmic for a few days, returning to normal if infection does not occur.

Two less common varieties of middle-ear injury may be seen:—

Delayed perforation.

Perforations in chronic adhesive otitis media.

### DELAYED PERFORATIONS.

Following an explosion there is at first a massive hæmorrhage into the substance of the tympanic membrane. In a few days the drum fibres in this area necrose and give way, and a large dry perforation results.

# Blast Injuries of the Ear

## Perforations in Chronic Adhesive Otitis Media

The thin atrophic drum in this condition readily ruptures, often from seemingly slight causes, and with little disturbance. The patient may complain that his ear went "crack". On examination, there is found one, or sometimes two small central perforations, with no surrounding hæmorrhage or reaction.

The site and size of the perforation of a blast injury varies, though it is always large, and quite unlike the linear split of the traumatic perforation of civil life. The attic region is never affected.

It may be impossible to distinguish a blast injury in its later stages from a chronic suppurative otitis media, granulation tissue occurs equally readily in both.

## Deafness in Middle-Ear Injuries

Unless there is an associated injury to the internal ear, deafness is not more severe than in an otitis media of inflammatory origin. Rupture of the tympanic membrane appears to protect the cochlea for the most severe injuries of the inner ear are found where the drum is intact.

## Infection

Infection is still common, even though medical officers now rarely put in drops or syringe injured ears. Fifty six per cent of the cases analysed were infected when first seen. But it must be remembered that the middle ear may become infected not only, though most commonly, from the external meatus, but also *via* the Eustachian tube from the nose and throat as the following case record shows —

Basuto soldier. Admitted to hospital one hour after he had exploded a detonator in his tent, in order, as he afterwards explained, to make a loud noise.

On Admission — On examination his general condition was very good. He was complaining of deafness.

Left Ear — Tympanic membrane a little injected.

Right Ear — Fluid blood oozing through a large central perforation.

Nose — A quantity of yellow pus in the right nostril apparently coming from the right antrum.

Fauces and Post-Nasal Space — Normal.

No hearing tests were done owing to language difficulties. The right external meatus was lightly plugged with sterile cotton wool. Sulph-anilamide 2 gms as an initial dose, followed by 1 gm four-hourly.

Third Day — Nasal swab report — Hæmolytic streptococci. Right antrum wash out — Some large blobs of pus recovered.

Right Ear — A few flakes of dry blood in the external meatus. Large perforation in the anterior quadrant. Ear dry.

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Fourth Day.—Right Ear.—Cotton wool damp with a serous exudate, pool of sero-pus in middle ear, especially in region of eustachian orifice.

Fifth Day.—Right Ear.—Discharge frankly purulent. Aural swab :—Hæmolytic streptococci.

Further course.—Eventual recovery from otitis media and discharged from hospital with a dry ear, though there was no healing of the perforation. There was no gross hearing loss. The antrum infection subsided after repeated wash-outs.

## Treatment of Middle-Ear Injuries

Treatment of blast injuries of the middle ear has two main aims ; to prevent infection, and to clear up any infection which has supervened.

For the recent case local interference should be restricted to plugging the external meatus lightly with sterile cotton wool. Sulphanilamide powder is not advised. By mouth 2 gm. of sulphanilamide are given as an initial dose, followed by 1 gm. every four hours until 25 gm. are given.

The treatment of an established infection is that of any acute otitis media. Sulphanilamide by mouth ; local toilet of the external ear—careful mopping away of all debris, aspirating pus from middle ear, and dressing with half-inch wide ribbon gauze ; zinc ionization is a useful therapeutic measure. Any nasopharyngeal sepsis is treated.

## Complications

Cases of infection proceeding to acute mastoiditis and requiring operation are uncommon in my experience. After the initial acute infection settles down and the patient is discharged, he may suffer from recurrent otitis media requiring hospital treatment.

## Prognosis

In the absence of associated inner-ear injury, the prognosis as regards hearing depends on the severity of the initial injury, and the length of time any superadded infection has persisted. Perforations whose boundaries are solely tympanic membrane, or which are bounded partially by the tip of the malleus usually heal. Large perforations with damage to the malleus, or perforations partially bounded by the tympanic annulus, usually do not.

### MIDDLE-EAR INJURIES.

Duration.	Symptoms.	Findings.	Treatment.	Result.
24 hours.	Bleeding from right ear. No other complaint. Caused by ammo. explosion.	Left ear : Normal Right ear : Recent injury, large central perforation.	Sulphanilamide gms. 25. Cotton wool plug.	No infection. Discharged in 11 days. Perforation healed 28 days later.

# Blast Injuries of the Ear

## MIDDLE-EAR INJURIES

Duration	Symptoms	Findings	Treatment	Result
24 hours	Bleeding from right ear Nil else Ammo explosion	Left ear Normal Right ear Recent injury peripheral perforation Nil else—abnormal	Sulphanilamide gms 25 Cotton wool plug	No infection Discharged in 14 days No healing of perforation in 28 days
24 hours	Complained of deafness and tinnitus No bleeding noticed by patient Ammo explosion	Left ear Normal Right ear Recent injury Horse-shoe shaped central perforation tip of long process of malleus fractured	Sulphanilamide gms 25 Cotton wool plug	No infection Discharged in 21 days No healing in 28 days Hearing slightly better
24 hours	Complained of deafness and tinnitus No bleeding noticed Ammo explosion	Left ear Horse-shoe shaped central perforation Right ear Central perforation	Sulphanilamide gms 25 Cotton wool plug	No infection Discharged in 14 days In 28 days right ear healed left unchanged Hearing recovered
24 hours	Complained of deafness Ammo explosion	Left ear Injected Right ear Recent perforation at umbo bounded by tip of malleus	Sulphanilamide gms 25 Cotton wool plug	No infection Discharged in 14 days No healing of perforation in 28 days but hearing recovered
4 days	Complained of slight deafness and tinnitus Caused by firing a Bren gun	Left ear Tympanic membrane retracted Right ear two small perforations central and peripheral Nose Chronic ethmoiditis	Cotton wool plug	Dry one month later Some exudate in left middle ear No tinnitus Hearing not much better
4 days	Tinnitus and rather indefinite history of vertigo Caused by mortar bomb	Left ear Recent injury central perforation Right ear Nil	Sulphanilamide gms 25 Cotton wool plug	No infection Discharged in 11 days Perforation healed
11 days	Complained of deafness No other complaints Caused by bomb explosion	Left ear Small dry central perforation Right ear Dry perforation at umbo	Cotton wool plug  An associated inner ear injury	One month later both perforations healed Still complained of deafness Cold caloric test (60°) Left ear Reaction in 70 secs Right ear Reaction in 85 secs

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## MIDDLE-EAR INJURIES

Duration.	Symptoms.	Findings.	Treatment.	Result.
17 days.	Complained of ear discharging for 14 days. Caused by shell explosion.	Left ear: Mucoid discharge from central perforation. Right ear: Normal.	Daily toilet—mopping, dry wick, etc.	Ear dry in 6 days. Discharged in 14 days with perforation healed.
1 month.	Complained of tinnitus and some dullness of hearing. No otorrhœa. Caused by mine explosion.	Left ear: Dry horse-shoe shaped perforation round malleus. Right ear: Dry perforation at umbo.	No treatment.	Evacuated from area with other wounds.
1 month.	Ear began to discharge 3 weeks ago. After firing 40 mm. gun.	Left ear: Profuse mucoid discharge. Perforation at umbo. Nil else abnormal.	Sulphanilamide. Daily toilet.	Ear dry and perforation healing on discharge in 21 days. Not seen again.
1 month.	Complained of deafness and otorrhea for about 3 weeks. Caused by bomb explosion.	Left ear: Large horse-shoe shaped perforation. Right ear: Almost complete destruction of drum. Very profuse discharge from both ears.	Sulphanilamide gms. 30. Local toilet. Zinc ionization, three times.	28 days treatment. Both ears dry on discharge. Still complained of deafness, though hearing improved.
1 month	Deafness, apparently very severe. Grenade injury.	Left ear: Dry peripheral perforation. Right ear: Normal. Hearing: Loud voice at 1 ft. Chronic ethmoid infection.	Unusually severe hearing loss, probably associated with inner ear injuries. No record of cold caloric test on right ear, patient only seen once before evacuation with other injuries.	
6 weeks.	Profuse otorrhœa. Mortar bomb injury.	Left ear: Very profuse discharge. "Reservoir" sign positive. Swab: <i>B. Pyocyaneus</i> in pure culture. Nil else abnormal.	Cortical mastoid operation. Normal course.	Discharge in 3 weeks. Perforation healed, good hearing.
2 months.	Complained of deafness. Left ear bled for a period after injury. No tinnitus, no otorrhœa. Firing 17 pounder.	Left ear: Scarring of healed central perforation. Hearing: Normal voice 6 in. Right ear: Normal. Cold caloric (60°F.) Left ear: 85 secs. Right ear: 45 secs.	Patient evacuated with other wounds (GSW). An example of a healed injury to the middle ear, with persisting damage to the inner ear.	

# Blast Injuries of the Ear

## MIDDLE EAR INJURIES

Duration	Symptoms	Findings	Treatment	Result
3 months	Otorrhœa since injury Caused by shell explosion	Left ear Central perforation Profuse, purulent discharge	Sulphanilamide gms 30 Local toilet	Ear dry after 2 weeks, though perforation unhealed Not seen after discharge
3 months	Complained of deafness tinnitus and otorrhœa After firing PIAT gun	Left ear Nil Right ear Central perforation profuse discharge Chronic nasal sinusitis	Local toilet	Ear dry in 7 days and patient discharged, but readmitted twice in 3 months with recurrence of otitis media
3 months	Complained of otorrhœa Onset after firing 3 7 in gun	Left ear Large central perforation purulent discharge Right ear Normal	Aural toilet Zinc ionization	Discharged in 5 days with a dry ear Not seen again
5 months	Complained of constant otorrhœa since injury Caused by bomb explosion	Left ear Healed perforation at umbo Right ear Very large central perforation Profuse discharge Nil else	Aural toilet Zinc ionization (twice)	Discharged in 5 days with ear dry 28 days later ear still dry but no healing of perforation
12 months	Constant right otorrhœa since injury Caused by firing of 17 pounder	Left ear Dry peripheral perforation Right ear Very large perforation bounded by annulus Profuse discharge	Toilet Zinc ionization (twice)	Moved from area in 14 days Still a profuse discharge when last seen
12 months	Constant otorrhœa since injury 12 pounder	Left ear Nil Right ear Purulent discharge Horse shoe shaped perforation	Zinc ionization	Moved from area before result of treatment observed
18 months	Otorrhœa since injury Caused by shell burst	Left ear Peripheral perforation Very profuse discharge Granulation tissue protruding No gross hearing loss Nil else abnormal	Aural toilet Removal of granulations Zinc ionization (three times)	Discharged in 28 days, ear dry Still dry 3 months later
2 years	Intermittent otorrhœa since initial injury Caused by bomb burst	Left ear Mucoid discharge Central perforation Right ear Normal Nil else abnormal in nose or throat	Zinc ionization	Moved from area after 14 days ear not dry though discharge much less



# D. H. Craig

## MIDDLE-EAR INJURIES

Duration.	Symptoms.	Findings.	Treatment.	Result.
2½ years.	Constant otorrhœa since injury. Never any ear trouble before bomb burst near him. Pain in ear for past week.	Left ear: Profuse discharge. Drum injected. Peripheral perforation much granulation tissue protruding. Right ear: Normal. Nil else abnormal.	Sulphanilamide 30 gms. Aural toilet. Removal of granulations. Zinc ionization.	Dry ear when finally discharged 3 months later.
4 years.	Otorrhœa since a 4 in. naval gun fired near him.	Left ear: Normal. Right ear: Central perforation, purulent discharge. No granulations, no gross sepsis in nose or throat.	Aural toilet.	Ear dry on discharge 1 month later. Not seen again.

### Injuries mainly affecting the Inner Ear

These injuries may be considered in three groups according to their degree of severity. Those least affected, whose hearing loss is slight, complain mainly of tinnitus. They are often found to be suffering from chronic nasal infections, and their ears may have been injured by relatively minor trauma.

The moderate degrees of inner-ear injuries have an obvious hearing loss. At first the upper tones alone are affected, then both upper and lower ends of the auditory scale are contracted, and finally in the most severe cases no sound at all can be heard. Usually only one ear is so severely deafened, and the hearing is not entirely lost in the other.

Pain is not often felt. A curious complaint sometimes made is of numbness around the ear, "as though they had received a blow while boxing" is a common description of this sensation.

Severe cases of inner-ear injury are difficult to examine, and to distinguish from hysterical deafness; especially in foreign or primitive races. Tuning fork tests are not very helpful, even where some hearing is retained, for such patients often have difficulty in understanding what is required of them, and may fail to distinguish between the note of the fork, and the sensation of vibration felt at its base. The cold caloric test provides a rapid and reliable method of distinguishing among the severely deaf, those patients who have a lesion of the inner ear from those who have not.

The test was carried out as follows:—The patient sat in a chair, with the head erect looking straight to the front, and the ear to be examined was irrigated with water at 60° F. Before beginning to test the ear, the bulb of the thermometer was first syringed with water until a steady reading was obtained.

## Blast Injuries of the Ear

The time taken from the beginning of the irrigation until the first appearance of the nystagmus was noted. It was found from examination of a series of normal people that over one minute was a delayed response.

Though the main value of the test is not to estimate the amount of inner ear damage, there was a definite relationship between the length of time required to elicit the nystagmus and the severity of the hearing loss; and in a few cases where a personal follow up was possible, there was found to be a diminution in the reaction time as the hearing improved. This is illustrated by the following case:—

Gurkha aet 26. Six weeks before examination a shell exploded near him, and he became quite deaf for a few days. He had no pain or dizziness. His ears did not bleed. There had been a roaring in the ears, but this has now ceased.

On examination.—Intelligent-looking man. Hearing:—Loud voice at 1' ft.

Right Ear.—Tympanic membrane normal. No forks heard either by air or bone conduction. Cold caloric test:—Response in 90 secs.

Left Ear.—Tympanic membrane normal. Forks heard by air and bone conduction. Bone conduction much reduced.

N.B.—The two forks provided in the Army E.N.T. Set are C256 and C512.

Cold caloric test.—Response in 70 secs. Nose and throat were normal.

One month later.—Right Ear:—C256 heard by air conduction. Cold

caloric test:—Response in 65 secs. Left Ear.—Cold caloric test:—Response in 60 secs.

There was an evident improvement in the hearing, a normal conversational voice could be heard without much difficulty.

### Treatment

No treatment benefits these patients.

### Prognosis

The prognosis must be guarded. Though most do well eventually, especially if the cold caloric test is little delayed, it is possible that progressive degenerative changes may have been initiated at the time of the injury which will manifest themselves in later life. A very prolonged reaction time for the caloric test is ominous.

Tinnitus may continue for years, even where the hearing had returned completely, this is especially so in patients who have nasopharyngeal sepsis. The severity of the tinnitus has no relationship to the hearing loss.

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## INNER-EAR INJURIES.

### SLIGHT.

Duration.	Symptoms.	Findings.
5 days.	Complained of tinnitus in both ears, and slight deafness in right. Had been firing a rifle all day at floating mines.	Both tympanic membranes normal. Left ear : No demonstrable hearing loss. Cold caloric reaction 30 secs. Right ear : Loss of bone conduction for high notes. Cold caloric reaction 40 secs. Nose and throat : Normal.
1 month.	Complained of deafness in right ear, not complained of tinnitus. States that he was subject to colds. Onset after firing a 6 pounder gun.	Left ear : Normal appearance. Cold caloric reaction 40 secs. Right ear : Normal appearance. Tuning fork tests not done. Cold caloric reaction 80 secs. Nose : Septum deflected to the right, airway obstructed on right side. Mucosa of turbinates oedematous and "boggy" muco-pus right nostril. Right antrum : wash out. Flakes of pus.
1 month.	Complained of tinnitus right ear. No other complaints, "always had nasal catarrh." Onset after firing a 40 mm. gun.	Left ear : Normal appearance. No obvious hearing loss. Cold caloric reaction 45 secs. Right ear : Normal drum. No obvious hearing loss. Cold caloric reaction 60 secs. Nose : Chronic ethmoid infection. Fauces : Normal. Post-nasal space : Mucopus both sides.
5 months.	Complained of tinnitus. Slight deafness in right ear. Nose "blocked up" especially at night. Onset after firing a 3.7 mm. gun.	Left ear : Drum a little retracted. Cold caloric reaction 35 secs. Right ear : Drum a little retracted. Tuning fork tests normal. Cold caloric reaction 50 secs. Nose : Nasal mucosa pale, oedematous swollen, no pus ; appearances suggestive of allergic rhinitis. Nil else abnormal.
18 months.	Complained of constant tinnitus in left ear since injury (bomb burst). At that time he was deaf in both ears for a few days. Hearing now "quite good". Subject to colds and suffers from nasal catarrh.	Left ear : Nil abnormal. Cold caloric reaction 40 secs. Right ear : Drum normal. Nothing abnormal on tuning fork tests. Cold caloric reaction 35 secs. Nose : Chronic rhinitis.
18 months.	Complained of constant tinnitus in left ear since injury. Never was deaf, never had any nasal catarrh. Injury due to firing a Bren gun.	Left ear : Nothing abnormal detected. Cold caloric reaction 30 secs. Right ear : Nothing abnormal on tuning fork tests. Cold caloric test not done. Nose : Normal.
2 years.	Complained of tinnitus in left ear since injury. Due to firing a 3.7 in. gun.	Left ear : Normal appearance. Cold caloric reaction 50 secs. Right ear : Normal appearance. Cold caloric reaction 40 secs. Nose : Chronic ethmoid infection Middle turbs. polypoid mucosa. Muco-pus in both nostrils. Post-nasal space : Posterior ends of inferior turbs. hypertrophied. Fauces : Normal.

# Blast Injuries of the Ear

## INNER-EAR INJURIES

### MODERATE

Duration	Symptoms	Findings
9 days	Mortar bomb explosion Complained of deafness in right ear since explosion	Left ear Drum intact, normal Cold caloric test 45 secs Right ear Drum intact Cold caloric test 1 min 45 secs
10 days	Shell explosion After which was totally deaf in both ears for twenty-four hours Was dizzy for three days Left ear still deaf, right much improved	Both tympanic membranes intact and normal in appearance Left ear No forks heard either by air or bone conduction Cold caloric test 1 min 30 secs Right ear Cold caloric test 60 secs (Tuning fork tests not done on right ear)
10 days	Bomb explosion Complained of deafness and tinnitus in right ear since	Both tympanic membranes intact Left ear Cold caloric test 50 secs Right ear Cold caloric test 65 secs No other hearing tests done owing to language difficulties
14 days	Mortar bomb explosion Complained of severe deafness for forty-eight hours Hearing has now improved Still complaining of tinnitus	Both tympanic membranes intact and normal Left ear Loss of upper tones Cold caloric test 1 min 15 secs Right ear No demonstrable hearing defect Cold caloric test 55 secs Nil else abnormal in nose or throat
1 month	Shell explosion Completely deaf for two days No tinnitus Some recovery of hearing in right ear Left still very deaf	Both tympanic membranes normal Left ear No forks heard Normal voice 2 ft Cold caloric test 1 min 40 secs Right ear Loss of upper tones Cold caloric test 1 min 20 secs Nil else abnormal in nose or throat
1 month	Caused by a mortar bomb explosion Tinnitus severe since explosion, and right ear deaf Left ear not affected	Both tympanic membranes normal Left ear No demonstrable hearing loss Cold caloric test 35 secs Right ear Forks not heard by air or bone conduction Cold caloric test 1 min 30 secs Nil else abnormal
1 month	Shell explosion Complained of absolute deafness for about forty-eight hours and tinnitus for a few days Hearing improved but not quite recovered	Both tympanic membranes normal Left ear Loss of high notes Cold caloric test 1 min 20 secs Right ear No detectable hearing loss Cold caloric test 50 secs Nil else abnormal
2 months	Mine explosion Complained of difficulty in hearing since explosion	Both tympanic membranes intact Hears loud voice with difficulty at 2 ft Left ear Cold caloric test 1 min 20 secs Right ear 1 min 30 secs Tuning fork tests not done Chronic nasal infection
4 months	Onset after firing a PIAT gun Complained of persistent deafness in the left ear since	Both tympanic membranes intact Left ear Cold caloric test 1 min 45 secs Right ear Cold caloric test 45 secs Nil else abnormal

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## INNER-EAR INJURIES.

### Moderate.

Duration.	Symptoms.	Findings.
5 months.	Shell explosion. Completely deaf for several days after explosion. Still deaf in left ear. Not complaining of tinnitus.	Both drums intact and normal. Left ear: Loss of high notes. Cold caloric test 65 secs. Right ear: No demonstrable hearing loss. Cold caloric test 30 secs.
2 years.	Firing a 12-pounder gun. Went completely deaf for a few days, then hearing improved, but never normal. Tinnitus ever since.	Both drums intact and normal. Left ear: Loss of high notes. Cold caloric test 65 secs. Right ear: No detectable hearing loss. Cold caloric test 45 secs. -Nil else abnormal.

## INNER-EAR INJURIES

### Severe

Duration.	Symptoms.	Findings.
1 month.	Onset following a bomb explosion. Absolute deafness since.	Tympanic membranes normal. Left ear: Cold caloric test 2 min. 30 secs. Right ear: Cold caloric test 2 min. 50 secs.
2 months.	Bomb explosion. Absolute deafness since explosion.	Both drums intact and normal. Left ear: Cold caloric test 3 min. 30 secs. Right ear: Cold caloric test 3 min. 45 secs.
2 months.	Bomb explosion. Absolute deafness since explosion.	Both drums intact and normal. Left ear: Cold caloric test. No response in 4 min. Right ear: No response in 5 min.
3 months.	Bomb explosion. Severe deafness in right ear. Left ear not affected.	Both drums intact and normal. Left ear: Cold caloric test 50 secs. No detectable hearing loss. Right ear: No forks heard. Cold caloric test 3 min.
5 months.	Onset after firing a 5.5 in. Deaf in both ears for a time, then right ear recovered. Left ear still very deaf. Always had nasal catarrh.	Both drums intact and normal. Left ear: No forks heard. Cold caloric test 4 min. Right ear: Cold caloric test 50 secs. Nose: Chronic ethmoid infection of apparently very long standing.

## Hysterical Deafness

A characteristic appearance is often found in individuals suffering from hysterical deafness. They enter the room with slow lagging steps, looking the picture of misery, and slump into the examination chair staring down at the floor, in abject woe. They seem quite unable to hear any sound at all; a state of affairs which may have persisted for many months.

This appearance is quite unlike the man whose deafness is associated with a prolonged reaction time to the cold caloric test who enters the room

## Blast Injuries of the Ear

with a firm step, and looks anxiously, with an alert rather bewildered air, at anyone he judges to be speaking.

The reaction time of the hysterical patient to the cold caloric test is well within the normal limits, and they often show the greatest agitation when their ears are being syringed. Quite unlike the individual with severe nerve deafness, who behaves as if the sensitivity of the meatal skin is reduced, and does not seem to mind the syringing at all.

Other hysterical paralyses may occur in these patients, though none were seen in the series analysed. I have notes of a sergeant, who, after Dunkirk, had an associated hysterical blindness of one eye, so real, that he stumbled over a chair, when the admittedly sound eye was bandaged up.

The patients are not malingerers. The loss of hearing is quite a real one, a noise while they are sleeping, will not waken them, and the cochleo-palpebral reflex cannot be elicited; that is, they do not blink when an unexpected noise is made near their ear. After the shock of the explosion, their belief that it is impossible for them to hear is so strong, that the deafness persists.

### Treatment

The treatment of these cases is a matter for the psychologists.

#### HYSTERICAL DEAFNESS

Duration	Symptoms	Findings
14 days	Absolute deafness since a mine exploded near him	No wounds, both drums normal Cold caloric tests — Left ear 35 secs Right ear 40 secs
1 month	Absolute deafness after a mine exploded near him	No other injury, both drums normal Cold caloric tests — Left ear 55 secs Right ear 45 secs
1 month	Absolute deafness after a shell exploded near him	No wounds, both drums normal Cold caloric tests — Left ear 30 secs Right ear 40 secs
1 month	Absolute deafness since a bomb exploded near him	No wounds Both drums normal Cold caloric tests — Left ear 50 secs Right ear 45 secs
1 month	Absolute deafness since he was buried in a house which had been hit by a bomb	No wounds Both drums normal Cold caloric tests — Left ear 45 secs Right ear 40 secs
3 months	Absolute deafness since a shell exploded near him.	No wounds Both drums normal Cold caloric tests — Left ear 35 secs Right ear 30 secs

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## HYSTERICAL DEAFNESS

Duration.	Symptoms.	Findings.
3 months.	Absolute deafness since a grenade exploded in a room he was in.	Had superficial wounds. Both drums normal. Cold caloric tests :— Left ear : 50 secs. Right ear : 45 secs.
5 months.	Absolute deafness after a mine exploded near him.	No wounds. Drums normal. Cold caloric tests :— Left ear : 35 secs. Right ear : 50 secs.

### Summary

Blast injuries of the ear are discussed.

Fifty-six cases are analysed.

The use of the cold caloric test in differentiating between hysterical and severe nerve deafness is described.

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## CLINICAL RECORDS

### A CASE OF RHINOSPORIDIOSIS

By H S SHARP, Major, R A M C and R BIGGS (Oxford)

(From an L M S Hospital and Department of Pathology Radcliffe Infirmary, Oxford)

In November, 1944, a native of India, now a member of H M Forces, attended for examination on account of right-sided nasal obstruction. Born in Rhamborasamber, Orissa, India in 1913, he first noticed trouble with his nose in 1931, when right sided epistaxis occurred, two years later he began to get nasal obstruction on the right side. At this time he was studying law and while in India sought no advice about his nose.

No members of his family have had any nasal or ocular disease, and he gave no history of handling animals nor of doing farm work of any kind.

In 1937 he came to England. During this year the right-sided nasal obstruction became progressively worse, so that in 1938 he went into hospital and had "polypi" removed from the right side. Since then he has had nine intranasal operations for recurrent polypi, the longest period of relief being six months.

The patient is well developed and healthy in appearance. General physical examination was negative.

On anterior rhinoscopy, the right nostril showed several bleeding polypoid growths, having the appearance of pale granulation tissue, on which could be seen small white spots. There was also a thin muco purulent discharge. The polypoid growths sprang from the anterior third of the septum and from the vestibule, immediately in front of the middle and inferior turbinates. (There was no stalk to any of the growths, which were multiple, each with a broad base.)

The left side of the nose was normal, as was also the post nasal space. The mouth, larynx and pharynx were normal, and the conjunctivæ and lachrymal apparatus clear.

X-ray investigation of all sinuses revealed no abnormality and the Wassermann reaction was negative.

The growths were removed by snare under local anaesthesia with galvanocautery to the base of each. A specimen was submitted for histological examination with the following findings—

*Macroscopically* the specimen (R I S H 3.475/44) consisted of two fragments of nasal polypi, each about 0.6 cms. in diameter.

*Microscopically* the polypi showed an irregularly papillomatous surface covered by squamous epithelium and a stroma of granulation tissue. The most striking feature was the presence throughout the stroma of encysted parasites. These were present in very large numbers and different stages in their development could be traced. The smallest forms were comparable in size to the liberated spores, they were uninucleate, surrounded by a thick wall and measured about 6-10  $\mu$  in diameter. A gradual increase in size was



## H. S. Sharp and R. Biggs

seen to occur with progressive nuclear divisions. Finally a stage was reached when the cytoplasm became condensed around innumerable nuclei to form endospores which were liberated by a rupture of the cyst wall. Mature spores were also seen lying on the surface of the polypi and embedded in the granulation tissue.

The tissue reaction to the presence of the parasites consisted in a cellular granulation tissue containing giant cells and numerous small abscesses. In many instances these abscesses were formed in relation to liberated spores. The polypi were covered by stratified epithelium which showed considerable irregularity in relation to subepithelial cysts.

The appearances of the parasite agree exactly with descriptions and specimens of *Rhinosporidium Seeberi* (Wernicke). This organism is a fungal parasite in which no sexual stage has been recorded. Attempts at artificial culture and animal inoculation have proved unsuccessful. Its exact relationships are doubtful, it bears some relationship to the Chytridiales but is probably a member of the Coccidioideaceae of the Endomycetales.

The condition of Rhinosporidiosis was first described by Seeber in 1900. Since then less than a hundred cases have been reported, the majority in orientals, though the disease is indigenous in South America, and a few cases have arisen in the United States and South Africa.

The disease usually affects men and involvement is limited to the nasal mucosa and conjunctiva. It occurs in animals but its mode of transmission is unknown. Its parasitic nature was recognized by Seeber, but Ashworth (1923) was the first to show that it was of fungal nature.

The characteristic finding is a bleeding polyp in the anterior part of the nose. When the growth obstructs the nostril the patient seeks relief. The polyps are usually single, though several may be present at the same time. Though the vestibule is most commonly affected, the polyps may extend into the anterior nares or back into the nasopharynx. Their colour is pale pink and if the surface be examined closely it will be seen to be studded with small white dots. Sometimes a pedicle is present, though more often the polyps arise direct from the nasal mucosa from a broad base. Papillary processes are sometimes present.

Confusion with new growth is easy on first inspection, but the history and microscopical investigation will disclose their true nature.

A thin muco-purulent discharge is always present in which the spores can be found.

Treatment in the greater number of reported cases has consisted of intranasal removal of the growths, with cautery to the bases of each. Wright (1922) has used a 2 per cent. aqueous solution of antimony tartrate for conjunctival lesions, and this solution might prove useful for local application to the nose after removal of the growths, to allay the constant recurrences.

We wish to thank Dr. A. H. T. Robb-Smith for advice in the preparation of this note.

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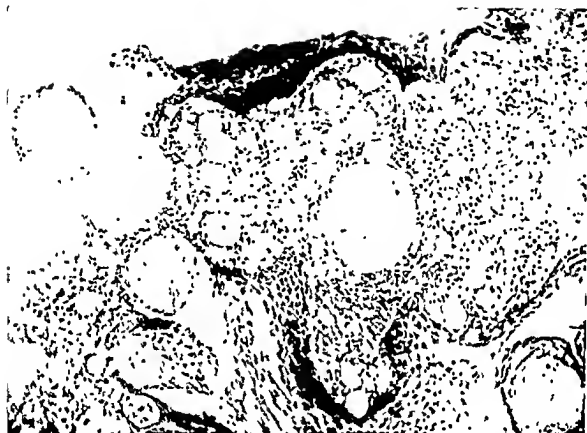


FIG. 1  
Section of Nasal Polypus showing *Rhinosporidium seeberi* in various stages of  
development  $\times 100$



## A REPORT OF TWO CASES OF PETROSITIS, TREATED WITH PENICILLIN

By PHILIP READING (Birmingham)

PETROSITIS is an unusual condition, and the individual experience of most surgeons is generally restricted to a few cases. Two successful cases are by no means sufficient basis on which to generalize, but the clinical histories, detailed below, do at least suggest that, with the increasing use of penicillin, the problem of treatment may become easier to solve. That is my only excuse for adding to the voluminous literature which has accumulated on the subject since the first description of the syndrome by Gradenigo in 1904.

CASE I. E.G., aged 18, developed pain in the right ear and aural discharge on 19.12.44. She was treated by her physician with Sulphanilamide by mouth, one gramme four-hourly, till 2.1.45, when I was asked to see her. During this period of treatment, her temperature had been fluctuating between 99°F and 101°F, and she had had severe pain over the right side of the head for about ten days.

On examination, pressure over the right mastoid process caused pain, and the patient also complained of a severe right hemicrania. Inspection of the right drumhead showed it to be acutely congested, with a profuse discharge coming from a mass of granulations, which partly hid a perforation of the postero-superior part of the membrane. The leucocyte count was 14,000 and bacteriological examination of the aural discharge showed the *Streptococcus hæmolyticus* to be the infecting organism. The hearing was markedly reduced in the affected ear. The girl was otherwise healthy, and no abnormality could be detected on examination of the nervous system.

A diagnosis of acute right mastoiditis, with, probably, an extradural abscess was made.

Right cortical mastoidectomy was performed the same day, the mastoid proving to be extremely cellular, with a widespread purulent infection of all the air-cells. An extradural abscess was found lying over the lower end of the lateral sinus and extending forwards over the cerebellar dura. A wide resection of bone was performed, with exposure of healthy dura around the granulations of the extradural abscess. Infected cells were traced into the petrous till the posterior vertical canal was exposed. The wound was dusted with Sulphanilamide powder, and the upper end of the incised soft parts closed over a drain. Hæmolytic streptococci were grown from a swab of pus from the mastoid cavity.

After operation, her progress was not unsatisfactory for a day or two. The discharge from the tympanum showed no sign of lessening, however, and the patient seemed listless, though she was free from fever. On 4.1.45 a seven-day course of Sulphadiazine was started, one gramme of the drug being given every four hours. The leucocyte count was 18,600. The hæmoglobin was only 65 per cent. and Ferrous Sulph. grs. 6 t.d.s. was given throughout the illness, to overcome this anæmia.

## Philip Reading

On 19.1.45 the discharge from both the mastoid wound and the tympanum continued as freely as before, and the patient complained of occasional pains in the right temple. It was clear that the chemotherapy had not arrested the infection. The anæmia was still marked, and the leucocyte count was 8,100.

On 29.1.45 the discharge was very profuse, and the patient complained of more neuralgic pain; a fever, rising to 99.5°F at night, was also present.

On 1.2.45, the pain was now worse and was felt behind the right eye, as well as in the temple. Neurological examination showed no abnormality; lumbar puncture revealed a cerebrospinal fluid at a normal pressure, and subsequent examination of the fluid showed no abnormality in the number of cells or its chemical constitution. As the anæmia was still present (Hæmoglobin 63 per cent.) a transfusion of one pint of fresh blood was given.

The clinical diagnosis of petrositis was now fairly clear, though X-ray examination of the apical petrosal cells was not conclusive. It was confirmed four days later by the appearance of a right external rectus paresis, which, in a further three days, had become a complete palsy.

During this time, the pain in the right forehead and behind the right eye had become worse, and she complained of a general headache. The appetite was lost, anorexia being succeeded by vomiting, when a meal was taken, and the patient became apathetic and lethargic. These symptoms were feared to be the heralds of some further intracranial extension of the infection.

The streptococci grown from the aural discharge were sensitive to penicillin; and systemic penicillin therapy was begun. Three-hourly intramuscular injections of 20,000 units were given for six days, and a total of 800,000 units was employed in all.

The immediate effect was dramatic. Four days after the beginning of treatment, the sinus at the lower end of the wound, which had been discharging pus through flabby, unhealthy granulations, had closed, and the perforation of the tympanic membrane also healed a day later. Both stayed firmly healed. This arrest of a discharge, which had persisted for over six weeks, in spite of the most careful local and general treatment, was very impressive. Not less noticeable was the improvement in the patient's general health, with return of appetite, cessation of vomiting and loss of the troublesome pain in the eye and temple.

By the date of discharge from hospital (27.2.45) the external rectus palsy had disappeared, and her hearing had returned so that she could hear a whisper at three feet. She has remained well since.

*Comment.* The continuing headaches, increasing in severity, the maintained, irregular temperature, the loss of appetite and vomiting, seemed to point not only to a petrositis, but also to an eventual meningeal invasion and a fatal outcome. Revision of the wound and conversion of the cavity into a radical mastoidectomy, with its consequent loss of hearing, was considered. An attack on the petrous apex was also contemplated. From both these unpleasant proceedings, the patient was rescued by the employment of penicillin.

CASE II. B.H., aged 15, had been previously healthy, with no history of ear infections before the present attack. Four weeks before admission,

## Clinical Records

he had had a severe attack of acute tonsillitis, which was followed by left otorrhoea. For a fortnight, he had been having pain over the left side of his head, and behind his left eye. This pain was growing steadily worse. Two days before admission he developed diplopia. No Sulphanilamide had been given by his private practitioner during this illness.

On admission, he was pale and looked ill, his temperature being  $101^{\circ}\text{F}$ . The left ear showed a nipple perforation of the posterior part of an acutely congested drumhead. A whisper could just be heard at three inches. Slight tenderness could be elicited by pressure over the left mastoid antrum. Neurological examination showed a paresis of the left external rectus muscle, and some stiffness of the neck on flexing the head was noticed.

A diagnosis of acute mastoiditis, petrositis and meningism was made. A lumbar puncture showed a clear fluid at a normal pressure, and microscopical and chemical analysis of the fluid showed no abnormality in it. A ray examination of the petrous apices was not performed.

A left cortical mastoidectomy was carried out the same day (12.45). On opening the mastoid the bone was found to be fairly cellular, with pus and thickened muco endosteum in all cells and particularly in the antrum and the inter sinus facial cells. A wide exenteration of the bone was carried out, with free exposure of the lateral sinus and of the temporal and cerebellar dura. A chain of small cells was traced forwards to the arch of the superior semicircular canal, the superior petrosal sinus and its attached dura being freed off the posterior edge of the petrous. The track of cells seemed to peter out behind the arch of the canal and no attempt was made to trace them further. The wound was dusted with Sulphanilamide powder, and the upper part of the incised soft parts drawn together with a suture over a drain.

Bacteriological examination of the pus from the mastoid showed hæmolytic streptococci and coagulase plus staphylococci, both of these were found to be sensitive to penicillin.

The day after operation, the temperature was raised ( $101.5^{\circ}\text{F}$ ) and the boy was complaining of increase of pain behind the left eye. The white blood count was 13,400, and Sulphamethazine, one gramme four-hourly, was given by mouth for six days, the total dosage being 35 grammes.

This treatment seemed to have no effect on the amount of the discharge from the wound and ear, which continued unabated, on the fever, which ranged intermittently from 99 to  $102$ , or on the left temporal and retrobulbar pain.

On 10.2.45 systemic treatment with penicillin was begun, 15,000 units being given intramuscularly at three-hourly intervals until 12.2.45, when the dose was increased to 20,000 units. This treatment was maintained till 15.2.45, 720,000 units being injected altogether.

The fever disappeared twenty four hours after the penicillin therapy was begun. In three days, suppuration in both the tympanum and the wound had ceased. The pain was relieved and the boy's general condition improved. At the time of discharge (22.2.45), the abducent palsy had disappeared, the wound was firmly healed, and the tympanic membrane and hearing had returned to normal.

*Comment* An extensive exenteration of the mastoid air cells, with wide

## Philip Reading

exposure of the dura, and drainage of the cells in the proximal part of the petrous, followed by adequate chemotherapy with Sulphamezathine, failed to subdue the fever or arrest the pain and suppuration. The boy's general condition was fairly good, and it is possible that spontaneous recovery might have eventually followed, but, up to the time that penicillin was employed, there was no sign of improvement but rather of a gradual deterioration.

*Discussion.* According to Eagleton (1936), the vast majority of cases of petrositis show a tendency to spontaneous cure, about 15 per cent. end in abscess formation on one or other surface of the petrous, and about 5 per cent. continue throughout as a progressive thrombophlebitis leading uniformly to death.

Stirk Adams (1936), in a discussion at the Royal Society of Medicine, said that two separate clinical types of petrositis exist. The first, not often recognized but quite common, is exemplified in those patients who make a slow recovery from an operation for acute mastoiditis, and the chief signs are a mild, continued fever and increase of the pulse rate, with persistent discharge, but without the characteristic pain, or the less characteristic external rectus palsy. The second type is the precursor of meningitis.

Both the two cases reported above, particularly the first, would fall into the more serious category.

Treatment is usually conservative after a thorough cortical mastoidectomy, but as Kisch (1936) stated: "Operation (*i.e.* on the petrous) is indicated when meningeal signs, headache, torpidity, irritation, neck rigidity and vomiting show themselves and increase".

Much ingenuity has been shown in devising operations to reach the petrous tip. They fall into three main groups:—first, the anterior approach of Almour and Kopetzky (1931), or its modification by Ramadier (1933), where the canal of the internal carotid in the petrous is deliberately opened, second the approach through the loop of the concavity of the superior canal, and third the unlocking of the petrous, with wide mobilization of the dura from the anterior and posterior surfaces of the petrous, as advocated by Eagleton (1931). All these operations are technically difficult and not unattended by the danger of profuse bleeding (Gerling, 1939), of meningitis or of cavernous sinus thrombosis.

No matter whether the pathology of petrositis is osteomyelitis (Eagleton, 1931), thrombophlebitis, or an extension of infection along chains of air-cells (Profant 1931, Almour and Kopetzky 1930, Friesner and Druss 1930), it would seem that penicillin is the ideal instrument for its correction. The employment of these intricate operations may be soon restricted only to those cases which do not respond satisfactorily to penicillin. Such cases will probably be few and be caused by the presence of a sequestrum, of a localized abscess, or by infection with an organism resistant to the action of penicillin.

My thanks are due to Dr. Ware, of the Pathology Department, Selly Oak Hospital for his helpful collaboration.

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## CLINICAL NOTE

### A STROBOSCOPE USING A GRID-CONTROLLED NEON TUBE, THE "STROBOTRON"

By W. BRYCE McKELVIE (Manchester)

A STROBOSCOPE may be used simply to measure the frequency of motion of an object where that motion is cyclic, or, as in the case of the vocal cords, it may be used to examine the object itself at any phase in the movement. An instrument which is satisfactory for the first purpose may be quite unsuited for the second and the following are some of the requirements for a stroboscope suitable for the examination of cord movements.

(1) The period during which the cords are visible must be a small fraction of one complete cycle, otherwise only poor definition is possible.

If the movement is sinusoidal and the time of observation is one hundredth of the periodic time, the movement during observation is approximately one thirtieth of the total swing. This movement is sufficient to make the definition poor and the observation of any harmonics almost impossible.

(2) The intensity of illumination during observation must be high to compensate for the viewing time being a small fraction of the total time.

(3) The frequency must be easily and accurately controlled over a 2:1 range.

(4) There should be no inertia forces to overcome, so that the response to the frequency control is immediate.

It may be noted here that an instrument possessing characteristics (3) and (4) may have its frequency controlled automatically by the object under observation.

(5) If required for portable use, the instrument must, of course, be small, light, easily erected and adapted for use on a normal lighting circuit.

Stroboscopes in general are of two types. In the first (such as Powell's laryngo-stroboscope) the light is constant and the period of observation is controlled by some form of shutter placed between the source of light and the object, or between the object and the eye of the observer. In the second type, the light itself is intermittent, so that the period of observation is controlled by the duration of the light flashes. Electric lamps of the incandescent filament type are unsuitable for the second type, as the time lag in heating and cooling the filament makes high frequency flashes of short duration impossible. The gaseous discharge type of lamp is free from this defect and it is to this type that the "Strobotron" belongs.

The normal "neon" lamp is a familiar example of this type of lamp. It has two electrodes in a bulb containing neon gas, the luminous discharge occurring when the voltage between anode and cathode exceeds a certain critical value.

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The "Strobotron" is a neon tube, but, in addition to the anode and cathode, it has two "grids", which give a further control of the discharge. With 400 volts between anode and cathode there is no discharge until a smaller control voltage is applied between one or both parts of the grids and the cathode.

The complete apparatus consists of three main parts.

The first is a standard type of D C supply unit, which is connected to an ordinary A C lighting, giving a D C output of about 50 milliamps at 400 volts.

The second unit is the frequency control circuit, by which the strobotron can be made to flash at frequencies of 200 to 400 per second. For hand control only one of the two grids of the strobotron is used and the voltages are supplied to both plate and grid from a condenser. This condenser is charged from the D C supply unit through a resistance, the time to charge up being controlled by varying the resistance. This resistance gives control of the range of frequencies but does not need adjustment for variations over a 2:1 range. The fine control of frequency is obtained by connecting the grid of the strobotron to a variable point on a potential divider across the main supply circuit. Adjustment of this potential divider by one knob gives smooth control of the light frequency from, say, 200 to 400 cycles.

The duration of each flash with the circuit used was less than one hundred thousandth of a second.

A telephone earpiece, connected to the second grid of the strobotron, which is not necessary for hand control of the frequency, gives a note of the same frequency as that of the light flashes.

As there are no moving parts in this frequency control arrangement, a change of frequency needs practically no power in the control circuit and the response is instantaneous. Automatic frequency control may easily be added to the apparatus. This is done by connecting a microphone through an amplifier to the second grid of the strobotron instead of the monitoring telephone used with the manual control described above. The amplifier is not elaborate, as linear amplification was found to be unnecessary. If any note is produced within the frequency range for which the stroboscope is set and picked up by the microphone, the light flashes are immediately synchronized with the frequency of the sound. The vibrating body (the vocal cord) producing the note then appears stationary when viewed by the light from the stroboscope.

The apparatus was devised before the war and the ripple movement at the edge of the vocal cord was seen. This movement has been observed also by cinematographic methods but this method of examination is not one for the consulting room.

The strobotron apparatus has its uses in the functional disorders of the cords, in the detection of impaired mobility of the cords in infiltrations by growth or infection.

It had been hoped to improve the intensity of illumination but war conditions have not allowed improvements to the machine.

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In the early years of the period, much attention was paid to general effects of chronic foci of infection. A good many of the theories of that period have been abandoned. I may remind you of the treatment of pernicious anæmia before the advent of liver therapy. There are still cases of general ill-health, mental disorders and some types of rheumatism which have their main origin in focal nasal infection. In more recent years, it has been increasingly realized that disease in other organs may affect the nose. In this connection I would recall the discussion on Blood Diseases before this Section in April, 1942. The war has speeded progress in the study of the effects of environment upon mental and physical health. This in turn has led to improved practical measures in the prevention of disease. Diet, and in particular the vitamin content, has been the subject of many clinical and animal experiments. Less well-known is the work of Jarvis on nasal disorders caused by faulty carbohydrate metabolism. A recent advance in the prevention of cross-infection is the application of spindle oil to ward floors and furnishings.

As perhaps the best example of a condition needing for its management all the qualities of a physician, I come now to the consideration of vasomotor disturbances. To my mind, the most important advance in the last twenty years has been the increasing recognition that vasomotor disturbances simulate, both clinically and radiologically, the changes due to bacterial infection. When vasomotor conditions are treated by methods suitable for infection, the results fully justify all the criticisms which have been hurled at rhinology. The symptoms of more than half the patients we see are either wholly or partly of vasomotor origin. One of the chief problems in everyday work is to decide whether symptoms are due to infection, vasomotor disturbances or to a combination of both conditions. The pioneer work in this field is due to those who now style themselves allergists, and to whom full credit must be given. Nevertheless, I dislike the term "allergy" as it implies that œdema of the nasal and sinus mucosa and of cranial structures, is invariably the result of sensitization. It is more in accord with clinical facts to recognize that many individuals are born with an unstable vasomotor system, and that many factors may bring this instability to light. As individuals, those who suffer from this disability are often above the average in intelligence, and hold positions of responsibility. All of us can recall cases in which the breakdown of control was caused by fatigue, and that nearly always this fatigue was the result of mental turmoil. The relationship between the emotions, the sympathetic nervous system, and the ductless glands is well-known. Menopausal vasomotor rhinitis is a definite clinical entity; we must be on the look-out for less obvious breaks in the chain. The problem becomes even more complicated when it is realized that, in susceptible individuals, a transient, nasal infection may act as a trigger, and further complicated by the fact that surgical operations on "allergic" patients are followed by a period of relief. Rhinologists are often called to help in the diagnosis of headache. It is my experience that many such cases are of vasomotor origin, and that migraine in its various forms should always be kept in mind. Structural abnormalities and positive X-ray findings, the result of vasomotor œdema, are common in such patients and a frequent source of error. It is only by taking a careful and detailed history that such errors can be avoided.

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There is to-day a practical implication in the thoughts I have attempted to bring before you. During recent months we have all been much occupied with plans for the better education of the nose and throat surgeon of the future. Post graduate education must be planned on a broad basis. In the past emphasis was laid on a general surgical training, and little, if any, attention was given to post-graduate training in general medicine.

Should we not return, at least to some extent, to the ways of the pioneers of medicine, and we might do worse than bear in mind the old saying, "A good doctor should know a little of everything, even of medicine."

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## DISCUSSION ON MEDICAL ASPECTS OF RHINOLOGY

GEOFFREY EVANS, in opening the discussion, said that the health of the upper respiratory tract was of vital concern to every physician, because diseases in this area were the cause of systemic disease and were themselves incapacitating. Putting aside neoplasms and specific infections such as tuberculosis and syphilis, his object was to give the physician's approach to common chronic infections of the upper respiratory tract. The approach was the same as to infections elsewhere in the body. The illustration of *B. coli* infection of the urinary tract might be taken. If it was a simple and uncomplicated infection all that needed to be done was to give a sulphonamide in adequate dose, and one might expect, if it was a simple infection, cure after seven or eight days' treatment, perhaps less. A failure to cure made one think of some complicating condition. The same held good for the upper respiratory tract, for a common cold lasted five to ten days and catarrh of longer duration suggested a complication of it.

A man aged 56 came on account of shortness of breath due to emphysema, asthma and chronic catarrh of both upper and lower respiratory tracts. On examination he was found to have a number of infected teeth, the left antrum was dull to transillumination, and the right rather dull. His left antrum was washed out by Mr. Jory, and pus was found in it. Sixteen grossly infected teeth were removed. Eight months later both antra were clear and their washings were clear. Dental sepsis, especially in the upper jaw, was the cause of chronic infection of the antra, quite comparable to calculous disease of the kidney complicating *B. coli* infection.

Another patient illustrated a different point. It was well-known that *B. coli* infection of the urinary tract could not be cured simply by sulphonamides if there was stagnation in some part of the tract, and the same held good for the upper respiratory tract. A man who was very subject to colds and some obstruction of his left nasal passage which prevented adequate drainage of his left antrum. This was cured by a surgical procedure, and the man since then had been practically free from colds. A good nasal airway was as important as a free passage of urine from the kidney to the external meatus.

Turning from local to general conditions. In textbooks of surgery dealing

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with the upper respiratory tract the importance of paranasal sinusitis in causing anæmia and general debility was emphasized, and this, of course, was indisputable. That being so, the approach was to put the local condition into order first and expect the general condition to improve in consequence. The physician's approach might be different, because it was known, illustrating again from *B. coli* infections of the urinary tract, that these occurred when patients were debilitated. For instance, he recalled the case of a patient with a severe hypochromic anæmia (hæmoglobin 60 per cent.), who failed to respond to treatment for a *B. coli* infection of the urinary tract, but who responded to treatment after being cured of his anæmia.

The physician's approach, therefore, was to restore general health and strength as far as possible to normal, and the effect which this had on the upper respiratory tract on occasion was as good as in the case he had quoted in which the sinusitis healed as a result of removing local sepsis. Considering more general causes of debility, as a physician he was impressed by the fact that many people were habitually over-tired due to going to bed too late at night, and he believed that this increased susceptibility to upper respiratory tract infections. Dr. Evans also referred to emotional stress and tension among the causes of lowered vitality undermining resistance to infection. Probably the upper respiratory tract, like other organs of the body, was not so resistant to disease if it was in a poor state of health. In the case of the digestive tract it was known that if a number of people eat infected sausage meat those with a good digestion were more likely to escape infection than those for instance, who had chronic intestinal catarrh. This brought him to the contribution he wished especially to make to this discussion. He wished to speak of health as distinct from disease of the upper respiratory tract.

The condition of the upper respiratory tract was often affected by digestive disturbance, and he cited the faucial congestion in chronic alcoholics as an example of this. He referred also to the congestion and chronic catarrh caused in some persons by smoking, and to the effect of climate in maintaining or clearing chronic catarrh. Further he emphasized the importance of the good ventilation of living rooms and bedrooms, and the need for good ventilators, especially in the rooms built without a fireplace. Lastly, to those who are prone to recurrent colds in the head and chronic catarrh there is a daily routine which may improve the health of the upper respiratory tract. In the first place a large handkerchief must always be used for blowing the nose, because this helped to prevent the spread of infection. He advised blowing the nose on waking in the morning and on going to bed at night. With a finger pressed on one nostril one should blow down the other, and then repeat the process on the other side. Twice a day ten deep breaths should be taken through each nostril, up one side and down the other, and then repeated in reverse. This made a difference to the nasal airway. Anyone who carried out this deep breathing through the nose would notice a clearing of the nasal passages after doing it. These exercises were combined with deep breathing exercises, expanding the lower thorax and restricting movement of the upper thorax. These exercises might also be helpful to those who suffered from sleeplessness. This matter of the common cold was so important in its effect upon employment, and upon the comfort and wellbeing of the individual,

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that it seemed to him that the hygiene of the upper respiratory tract would be a good subject for a leaflet distributed by the Central Council for Health Education

I SIMSON HALL It is by interference with the normal physiology of the nose that diseases, or derangements of metabolism, make themselves felt This may be absence of secretions or increase, or change in their consistency or overgrowth of one of the elements of the nasal mucosa

The diagnosis of the cause of the change is essential before treatment is commenced and the possibilities confronting us are many and complex It may be comparatively simple, as for instance a local deformity, there may be an environmental factor, or there may be some general disturbance which is obvious, or there may have been in the past some causal condition which has recovered, leaving a legacy of permanent pathological change which we can alleviate but not cure We frequently see patients, who, according to their own stories, or the opinions of their doctors, are suffering from internal troubles "because they are swallowing so much discharge that they are being poisoned"

The mucous membrane of the alimentary and upper respiratory tract is one continuous structure modified in parts for specialized duties, but still one, and it is possible that a systemic disorder which causes catarrh in one part, will cause similar disturbance in another, and the cure of catarrh in such cases lies probably with the physician as distinct from the rhinologist Another instance of mistaken cause and effect is sometimes encountered in chronic conjunctivitis, for which cure is expected by nasal treatment In the majority of cases, this does not take place

Endocrine dysfunction has received some attention following the work of Mortimer and his colleagues in Canada Whether his discovery that the local application of oestrogens is of benefit in atrophic rhinitis, means that this disease has its origin in endocrine dysfunction, is open to doubt, but it is certain that something is provided which enables the nasal physiology to more nearly approach normal

We are woefully ignorant of the effects of the variations of a patient's health upon the nasal secretions We know a little of the effects of changes of diet upon adenoids and other lymphoid tissues and of the improvements to be obtained by the adjustment of carbohydrate intake, but there our knowledge ends and we come to a region as yet completely unexplored in a scientific manner, and for the most part we do what our patients ask us to do, we treat their local symptoms Were early chronic nasal troubles of such a nature as to prevent work, or if they gave acute pain we could look for more co operation from our patients, but in the majority of cases, they are merely annoying and do not, in the patient's view, warrant any serious disturbance of a comfortable manner of life

Although we have been considering the effect of general conditions upon the nose, nasal infection has been blamed for many remote effects We are all familiar with the coupling of sinus infection with mental disorders, rheumatism, nephritis, peripheral neuritis, cardiac debility and a host of other conditions These connections undoubtedly exist but I believe that they are much more rare than has been thought and that much unnecessary surgery has been carried out because a brilliant result has been obtained occasionally

Undoubtedly there are conditions in which the necessity of nasal or nasal

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sinus treatment is now accepted without question, such as chronic lung suppuration. Here sinus investigation and treatment is an accepted part of the routine.

In the acute stages of nasal disease, general treatment may be little more than antifebrile as in the common cold, but where a causal organism has been identified chemotherapy or serum therapy may be considered advisable. In face of repeated infection, or for chronic forms of infection, prophylactic-treatment may be called for. This has been dealt with already but vaccine treatment must be mentioned. Vaccines have had a considerable vogue and I have prescribed them as autogenous and sometimes as stock or "grape-shot". I confess that as time passes I order them with an increasing lack of confidence in the prescription. Oral vaccines have also been used, but my experience with these has not encouraged me to continue. There are many so-called prophylactics but the experimental evidence on which their reputation rests is slender.

Local treatment of acute infection offers wide scope for ingenuity, but whatever treatment is preferred it should have some relation to the pathological condition at the time of its employment. The chief object in the view of the physician is the restoration of normal physiology at the earliest possible moment, and to accomplish this it is essential that there should be a clear conception of what the pathological cycle consists, so that the form of treatment most appropriate to the particular stage should be selected.

There are those who will argue that there is only one drug, and one solution which can be used in the nose without harmful effect, namely ephedrine in normal saline. As long as the mucous membrane is normal, or near normal, I entirely agree that the experimental proofs produced by Proetz are convincing, but under pathological conditions other applications are not only permissible but advisable. Inflamed mucous membrane requires to be soothed at certain times and no one can, by any stretch of imagination, call ephedrine in saline a soothing application to acutely inflamed membrane. For this reason oily preparations have a place and also isotonic douches, which help the reparative processes of the mucous membrane by clearing away the accumulated secretions, which deficient ciliary action cannot remove.

A great deal of our treatment is not strictly medical but falls into the category of physio-therapeutic treatment, in which we have various methods of applying suction to the nose, for the purpose of evacuating accumulated secretions, either in the nose or the nasal sinuses. This form of therapy includes the replacement method. There is not time to go into these in any detail, but my own experience has been that these methods are useful for improvement in early acute stages, but seldom achieve cure of themselves in cases of established infection. Replacement to me, has been most useful where a vasomotor factor was prominent. Heat or, alternatively, ice-packs are frequently comforting to the patient and helpful in allaying pain. It is doubtful whether in the acute cases they have anything more than a comforting effect to the patient, though I have to rely to some extent upon short-wave diathermy to assist the final clearing up of a case of sinusitis in which resolution appears to be delayed.

Any discussion of medical treatment of nasal infection at the present time,

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would be incomplete without mention of chemotherapy. There is little need to stress the value of sulphonamides as general therapeutic measures in cases of toxæmia. We are all convinced of their value. There is likely, however, to be more discussion upon the value of sulphonamides used locally in nasal infection. We are already familiar with the practitioner who recommends sulphonamide snuff or spray to his patients for every cold in the head. Manufacturers are making up sulphonamide sprays, gargles, and drops. This tendency to use sulphonamides for any and every purpose is to be deprecated unless there is some experimental background for believing in their value in such circumstances. With the idea of obtaining direct information upon this point, experiments are being carried out in the Department under my charge. The purpose of the enquiry is to determine by bacteriological study the suitability of sulphonamides for local use. This work follows, to some extent, the investigations carried out by Crowe and others.

This work is still only in its earliest stages, but it can be seen that the results of such investigations have to be received with caution. So far, a minority of cases show a positive result to the sulphonamide sensitivity test, so that the wisdom of administration of sulphonamides can be questioned on that ground alone. A further point which has been noted is that the organismal content of the nose has been lowered in some of the controls, pointing to the fact that mechanical irritation has had something to do with the reduction in organisms. How this may be brought about is suggested by the statement of more than one patient that nasal obstruction has been relieved after the administration of the control substance, the relief coinciding with the increase in secretion, a sequence of events with which we are already familiar in dealing with vasomotor troubles. It is possible that the out-pouring of secretions is responsible for the dilution of the organismal content. The main disadvantages appear to be nasal irritation, which threatens to become serious in one case treated with Sod. Sulphathiazole, and the possibility of sensitizing the patient to a drug which may be urgently required at a later date. These make it essential that further detailed studies along these lines be made before we can say whether or not this form of treatment can be recommended for general use. At the moment there seems to be more disadvantages than advantages.

Experience with penicillin has been necessarily limited but there has been opportunity to gain some experience with penicillin in cases of acute sinus suppuration, and such experience as we have had, has convinced us that under properly controlled circumstances, penicillin is one of the most valuable therapeutic measures at our disposal. It seems probable that it will completely change our outlook on what has hitherto been a most dangerous form of surgery, that carried out upon inflamed bone. In cases of chronic disease, the impression gained is that it is of doubtful value.

E. MUSGRAVE WOODMAN said that they were much indebted to the President for bringing this side of the picture to their notice. He himself had in his later career become more and more interested in medicine and more and more impressed by the medical aspect of these conditions. Many years ago his attention was drawn to a particularly interesting case—a patient



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who attended the doctor for an irritation of the skin around the vulva. A streptococcal infection of the urine was found and a vaccine was prepared, but every dose of the vaccine produced an acute tonsillitis. When the tonsils were removed she recovered both from the streptococcal infection and the skin lesion as well. To-day they were faced with numerous problems of that kind. Take, for example, the big operations for cancer of the larynx. It was not so much a question whether they could remove the cancer from the larynx, but whether the patient at his age would successfully go through the rigorous treatment prescribed for him, possibly in some cases in view of the fact that he had imbibed more alcohol than he should have done. Sometimes it was touch and go, and sometimes merely go.

He had found short-wave diathermy of great value, but had seen one or two quite disastrous results when patients, having refused an antrum operation, had preferred this more comfortable procedure.

The President had touched upon the difficult question of the education of the rhinologist or the ear and throat surgeon. He had always held that he should be a surgeon of experience because he took up the more difficult and delicate surgery in their specialty, but he was more than ever convinced that he should have a sound medical training. Therefore a rather high degree of medical education was needed for this specialty.

R. P. GARROW said that as one who had been in the public health service for many years he thought there was a great field for preventive medicine in rhinology. It seemed to him to work in two directions, namely, the way in which procedures in the nose, if well carried out, might assist the health of children, and, secondly, the way in which they might assist the many young people who, while suffering from nose conditions, also suffered from a poor physique, being flat-chested and round-shouldered. Attention to the physique of the child produced just as much improvement in the nasal condition as attention to the nasal condition produced in the general physique. He had been stimulated by the remarks of Dr. Geoffrey Evans. For the last seven years he had been a member of the Central Council for Health Education, and he shared his views about the usefulness of the pamphlets which that Council had put out in such large numbers.

T. B. JOBSON uttered a word of warning concerning short-wave diathermy in the treatment of nasal conditions, namely, the occurrence of a kind of telangiectasis. This annoying condition occurred in particular after the treatment of two cases in which he was concerned.

VICTOR NEGUS said that allergy had been mentioned, and this he found an extremely confusing subject. There were many cases of what he would term generally chronic œdema of the nasal mucous membrane, but not inflammatory; he very much doubted whether some of these were allergic, because if a condition were of this nature one should be able to find the allergen by one or other test and it should also be possible to hyposensitize the patient. But there was a condition of œdema of the nasal mucosa which depended partly on physical and partly on chemical factors, and it would be of great value if more research were carried out on this subject.

Some of these cases went on to polyposis; sometimes there was an excess of eosinophils, and allergy might be the cause, but in other cases all tests for

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allergens failed, and all treatments, whether by giving the patient's own serum or other sera, also failed, so that one was forced back on other forms of treatment

It was extremely difficult to decide what factors were at work. In attempting to write something on the subject of these non-inflammatory conditions of the nose he had found it necessary to include seasonal nasal allergy, generally known as hay fever, perennial nasal allergy or vasomotor rhinitis, and a third condition which had to be called chronic œdema of the nasal mucous membrane, the etiology being left vague.

DOUGLAS GUTHRIE said that most of the members had come to that discussion expecting to gather some hints on the treatment of the patient who complained of recurring colds or constant nasal catarrh, and who appeared to have a normal nose. Frequently they were already labelled as cases of sinusitis, and in order to oblige the general practitioner who had sent them, they underwent X-ray examination and lavage with negative results.

It was surprising that breathing exercises, which had a great vogue some years ago, now attracted less attention and little was heard of the importance of breathing exercises after removal of adenoids. Dr Geoffrey Evans has given some useful information on the effect of certain internal remedies upon the nose. Few definite investigations had been made upon the excretion of certain drugs in nasal mucus, but there was no doubt that certain facts had been established, first of all that there was a great deficiency of vitamin C in the nasal mucus at the beginning of an ordinary cold, and if large doses of vitamin C were given sufficiently early the cold could often be aborted.

C. A. PETERS said that it might interest rhinologists to know that in one of the formularies of the Hindu religion breathing exercises were prominent. He also mentioned a story concerning Napoleon, that he never employed on an important mission a man who had a snub nose. He always chose men with prominent noses, Napoleon's view was supported by his experience of Wellington.

## Folklore of Medical Rhinology

By J. D. ROLLSTON (London)

A little over thirty years ago in a paper on "The Medical Aspects of the Greek Anthology" read before the Section of the History of Medicine, I remarked that the Anthology contained many caricatures of local or general deformities, all of them the work of writers subsequent to the establishment of the Roman Empire. Among local deformities, large noses have always formed an attractive subject for the caricaturist. Twelve epigrams on this subject are to be found in the Anthology, of which the following are examples — "Hermocrates is a part of his nose, for if we say that his nose is part of Hermocrates we give a small name to a big thing" (*Anth. Pal.* xi, 198). "The house of Xenogenes was on fire, and in vain he sought to escape from the window by tying to it a long pole. But at length he espied the long nose of Antimachus and placing on it a ladder he escaped" (*ibid.* xi, 200).

Several epigrams, all by Lucilius, relate to the facial deformities produced by boxing. When we realize that the boxing gloves of the ancients consisted of thongs of leather studded with large iron nails, and recall the boxing contests in Homer and Virgil, the following epigrams will scarcely seem extravagant.

## Societies' Proceedings

"Olympicus whom you see in this state, Sebastus, once had a nose, skin, eyebrows, ears and eyelids, but in boxing he lost all, even his inheritance of which he could have no share. For his brother, who had his portrait, brought it to the court, and he was judged to be a different man, having no resemblance with the portrait." (*ibid.* xi, 75.)

"When Odysseus returned safe to his country his dog Argus alone recognized him, but after four hours' boxing, Stratophon, no dog nor fellow citizen could recognize you. If you look at yourself in a mirror you will say, 'I am not Stratophon'." (*ibid.* 77.)

In "A Note on the Early History of Rosacea" read before the Section of Dermatology in 1932, I drew attention to an epigram by the celebrated French humanist Marc Antoine Muret or Muretus on one Pompilius, "whose nose was four cubits broad and surrounded by a wall on either side and towers which Bacchus had dyed with vermillion"—in other words, a hyperbolical description of rhinophyma in an alcoholic subject which is in striking contrast with the sober realism of Chaucer in his portrait of the Miller in the Prologue to *The Canterbury Tales* :—

"Upon the cop right of his nose he hade  
A werte, and theron stood a tuft of heres,  
Reede as the berstles of a souwes eeres."



Ghirlandajo.  
Portrait of old man showing rhinophyma.

Other examples of monstrous noses in literature are supplied by the poet and dramatist Cyrano de Bergerac, best known by Rostand's play, and the fictitious Slawkenbergius in Sterne's *Tristram Shandy*.

As regards the iconography of what may be called *rhinitis externa*, Laignel-Lavastine in an article in *Aesculape* on "Pathological Noses in Classical Art", has reproduced portraits of rhinophyma, acne rosacea and neurofibromatosis involving the nose by Ghirlandajo, Hans Holbein the elder, Ribera, Daumier

# Royal Society of Medicine

and Raeburn The same journal shows a picture of rodent ulcer of the nose by Albrecht Dürer Reference may also be made to the terra cotta busts showing rhinomegaly in the National Museum at Athens (Hollander)

In a paper entitled "Rhinology and Folk-Lore" I have recently (1943) drawn attention to the popular belief in a close connection between the nose and the genital organs in both sexes which is summarized in the couplet.

Noscitur e labus quantum sit virginis antrum, -

Noscitur e naso quanta sit hasta viri

This relationship, however, between the two organs did not always hold good, and though it seemed at first to be confirmed by the work of Fliess and others, who under the title of "reflex neuroses" recorded a number of cases of uterine trouble which had been cured by treatment of abnormal conditions of the nose, it is now held that the supposed connection has been greatly exaggerated

Further information on this subject can be found in an article entitled "The physiological and pathological relations between the nose and the sexual apparatus of man" by Dr J N Mackenzie, professor of laryngology and rhinology at Johns Hopkins Medical School and laryngologist to the Johns Hopkins Hospital and Havelock Ellis's "Psychology of Sex"

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## THE BRITISH ASSOCIATION OF OTOLARYNGOLOGISTS

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### OTOLARYNGOLOGISTS IN THE SERVICES

The following recommendations on " Ways and means of safeguarding the interests of those returning from the Services who are intending to practice Otolaryngology " have been adopted by the Council of the Association and are being sent to the various bodies concerned.

1. While no specific action on the part of the Services on the one hand and the hospital authorities on the other can be expected to answer the many and diverse aspects of the problem, all concerned should earnestly co-operate.

2. The matter of prime importance is the undesirability of making any permanent appointments until such time as members of the Forces qualified to fill such appointments have had ample opportunity to present their applications.

3. It is no less important that the more junior posts (*e.g.* Registrar, Clinical Assistant) should be made available—even to the extent of giving preferential consideration—to those in the Services with some experience in Otolaryngology and anxious to continue in the specialty. In order to widen the prospects for these officers every suitable institution should create, as far as is practicable, more posts of this type.

4. In spite of recommendation 2 above it is realized that the time is approaching when certain posts will of necessity have to be filled. It will be difficult to do justice to Service applications unless some clear indication is given as to when such applicants can obtain their release or exchange.

5. The responsible authorities (*i.e.* the three Fighting Services and the Central Medical War Committee) should be asked to furnish explicit information regarding the procedure to be adopted for the release of officers likely to qualify for the types of appointment referred to in recommendations 2 and 3 above.

6. For the present it is hoped that where an appointment has of necessity to be advertised sufficient time (*e.g.* six months) will be allowed and the necessary opportunity given, for Service applicants in remote places overseas to apply. In order to effect this it is recommended that all such advertisements be sent to the Medical Directors-General of the three Fighting Services prior to publication in the Medical Press.

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